A

RETROFIT PACKAGE

FOR

GAS FIRED FURNACES

PHASE II

report prepared by

CLARE BROTHERS LIMITED

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Work on this project was conducted under the auspices of
The Canada Centre for Mineral and Energy Technology,
Energy, Mines and Resources Canada.

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TITLE: A Retrofit Package For Gas-Fired Furnaces, PHASE II

CONTRACTOR: Clare Brothers Limited,
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REPORT PERIOD: August 1982 - March 1984

OBJECTIVES:

1. To Obtain Approvals For Specific Field Installations Of Retrofit Packages.
2. To Carry Out The Installations And To Monitor The Performance On The Same.
3. To Carry Out Modifications Of Specific Components Developed In Phase I.

SUMMARY

For several years, there has been increasing interest in the development of higher efficiency (energy conserving) residential heating equipment. Clare Brothers was the first company in North America to design, manufacture and market a line of high-efficiency residential gas-fired furnaces. These furnaces fill the need in new homes and homes in which furnaces are due for replacement.

A further need has been identified - that of increasing the efficiency of existing gas furnaces that are in good operating condition but are not as fuel-efficient as possible.

Clare Brothers has addressed the problem, designed and field-tested a Retrofit Package for residential gas furnaces. The design and test process had resulted in an extremely viable piece of equipment which can raise the the seasonal efficiency of a standard gas furnace from approximately 60% to 90% and reduce heating costs by approximately 25 - 35%.

The unit is to be discussed at an upcoming I.G.A.C. meeting in June 1984. It is hoped that I.G.A.C. (Interprovincial Gas Advisory Council) will direct the Canadian Gas Association to test the retrofit unit. Obtaining certification will allow Clare Brothers to initiate marketing the developed product through our existing distribution channels in Canada.

TABLE OF CONTENTS

		Page
A.	INTRODUCTION	1
B.	TECHNICAL DISCUSSION	
	1. Field Test Program - Overview	1
	2. Field Test Program - Testing Procedure For Home Test Units	5
	3. Summary of Field Test Information	8
	4. Installation & Operating Manual	11
	5. Induced Draft Fan Design	12
	6. Pressure Control Design	13
	7. Heat Exchanger Coil Design	15
C.	APPROVAL STATUS	15
D.	CONCLUSIONS & RECOMMENDATIONS	17
E.	APPENDICES	
	(a) Approvals Documents - Field Test	
	(b) Field Test Agreements	
	(c) Retrofit Installation/Operation Manual	
	(d) Canadian Approvals Related Documents	
	(e) Individual Field Test Installations	

A. INTRODUCTION

In March 1979, a meeting was held between several heating equipment manufacturers, Utilities personnel, Interprovincial Gas Advisory Council (IGAC) personnel, Canadian Gas Association (C.G.A.) personnel and Energy, Mines and Resources, Canada (E.M.R.) personnel. The purpose of the meeting was to discuss methods of improving the efficiency of existing domestic gas furnaces.

Following the meeting, Clare Brothers submitted an unsolicited proposal entitled "A Retrofit Package for Gas-Fired Furnaces". A contract between Clare Brothers and Supply and Services Canada (Canadian Combustion Research Laboratories) was signed in November, 1979.

During the course of the contract, (November 1979 to March, 1981) Clare Brothers designed and tested several prototypes of a condensing type retrofit unit. The prototypes were designed to be inserted into the return air loop of the existing heating system. Consideration was given to the removal of condensate from the unit. Safety interlocks were designed to shut both the retrofit and original furnace down in the event of a system malfunction. Testing of the unit resulted in steady-state efficiency readings of 90 - 93% under laboratory conditions.

The success of this initial project encouraged Clare Brothers to seek methods of refining and testing the unit with an objective of obtaining a piece of equipment that is safe, reliable and commercially acceptable. As a result, Clare Brothers and Supply and Services Canada entered into a second contract in August, 1982.

The objective of this second phase was to install a number of retrofits in homes with different heat losses and different existing furnaces. The installations were to be monitored for reliability, safety and performance. In addition, Clare Brothers was to perform additional design and testing related to several components employed on the initial prototypes.

B. TECHNICAL DISCUSSION

1. Field Test Program - Overview

Prior to and following signing of the current contract, Clare Brothers held several meetings with Ontario Fuel Safety Branch personnel, Canadian Gas Association personnel, and Union Gas Limited personnel. The purpose of the discussions was to obtain the necessary approvals required to install twelve (12) retrofit units and required monitoring equipment in various residences located in Central Ontario. Ontario Fuels Safety Branch approval for twelve (12) installations was given in December, 1982. Further approval for six (6) additional units was granted in November, 1983 (See Appendix (a)).

Actual installations began in November, 1982 and were completed by January 31, 1983 for the initial twelve units. A legal agreement was signed between Clare Brothers and each homeowner, covering all aspects of the field test. (Copies attached - appendix (b)).

B. TECHNICAL DISCUSSION

1. Field Test Program - Overview...cont'd

Local Utilities were advised of the program by the Ontario Fuels Safety Branch and gave full support during the installation and monitoring segments of the program. Histories of gas consumption were provided for qualifying residences.

All installations were performed by local licensed contractors who had no previous experience in working with this type of equipment. Installation and initial start ups were performed without any significant problems. On completion of each installation the following operational and safety checks were made:

1) System input was verified.
2) Temperature rise was calculated.
3) Vent gas temperature recorded.
4) Vent piping layout documented.
5) Drainage system documented.
6) Thermostat heat anticipator adjusted.
7) Ventor motor failure test.
8) Incorrect mode test (each installation was vented so that the furnace could be switched back to its original mode of operation, in the event that a failure occurred in the retrofit system. This was accomplished through the use of a damper in a "T" in the flue pipe between the furnace, retrofit and existing chimney connection and by an electrical switch in the retrofit unit).
9) Power outage test.
10) Draft hood spillage test (linear limit control).

Results of tests are reported in Appendix (e).

Separate gas meters were installed in March, 1983 to isolate the gas consumption of the furnace at several of the locations. Not all locations required separate meters due to electric hot water heaters in some of the homes and out of town installations.

Each installation was inspected and approved by personnel of the Inspection Department, Approvals Division of the Canadian Gas Association. Each unit was identified by the inspector for future reference.

As directed by the contract Statement of Work, 12 furnaces were initially retrofitted:

- 2 Clare Sectional High Boy Units	- 1 input approx.	80,000 BTU/hr.
	- 1 input approx.	120,000 BTU/hr.
- 2 Clare Sectional Mid Boy Units	- 1 input approx.	80,000 BTU/hr.
	- 1 input approx.	120,000 BTU/hr.
- 2 Clare Drum Low Boy Units	- 1 input approx.	80,000 BTU/hr.
	- 1 input approx.	120,000 BTU/hr.

B. TECHNICAL DISCUSSION

1. Field Test Program - Overview...cont'd

- 2 Lennox Sectional Mid Boy Units - 1 input approx. 80,000 BTU/hr.
  - 1 input approx. 120,000 BTU/hr.

- 2 Olsen Duomatic Sectional Mid Boy Units - 1 input approx. 80,000 BTU/hr.
  - 1 input approx. 120,000 BTU/hr.

- 2 Flamemaster Sectional High Boy Units - 1 input approx. 80,000 BTU/hr.
  - 1 input approx. 120,000 BTU/hr.

Six of the installations were fitted with a smaller sized retrofit unit - the other six with a larger sized unit. Subsequent design, testing and costing exercises have shown that a single retrofit unit capable of handling furnace inputs between 60,000 and 125,000 BTU/hr. would be more appropriate than different sized retrofit units. Several new prototypes were constructed during the summer of 1983 incorporating the following features:

1) New induced draft fan assembly.
2) Clare manufactured, fin type heat exchanger coil.
3) Single "Tri-Delta" pressure control switch.
4) Simplified electrical control system.
5) Integral air filter.
6) Use of 3" dia. PVC pipe instead of 2½" dia.
7) Use of 4" dia. flexible stainless steel venting for connection between the furnace and the retrofit package.

Two further installations were made in October and November, 1983 on the following furnaces:

- 1 Preston Sectional Low Boy - input approx. 110,000 BTU/hr.

- 1 Chinook Sectional High Boy - input approx. 125,000 BTU/hr.

As well as being installed on furnaces of various input and manufacture, approximately half of the original furnaces utilized spark ignition systems with the remainder having standing pilots. No vent opening was provided for the standing pilot flame, however ongoing monitoring did not show any adverse effects in the house environments.

During the life of the field test, the installations were monitored on an ongoing basis by the homeowners and by Clare Brothers personnel. While virtually no problems arose from the operation of the units, there were comments made regarding noise and vibration from the induced draft fan and questions related to the efficiency of the units. Concerns regarding the induced draft fans have been resolved by replacing existing fan wheels with ones that have been balanced to a finer tolerance.

B. TECHNICAL DISCUSSION

1. Field Test Program - Overview...cont'd

The questions regarding efficiency of the units appeared to be a result of the homeowners not seeing a lot of condensate being produced, as occurs in Megasave I high-efficiency gas furnaces. However, as will be shown in B-2, the units are all operating at much higher efficiency levels than the original furnaces. The lower efficiency and resulting lower amount of condensate produced (compared with Megasave I furnaces) is a result of the dilution air being pulled through the draft relief opening of the original furnace with a consequent lowering of the flue product dew point.

At present Clare Brothers is having discussions with Supply and Services Canada to arrive at an equitable agreement to allow each homeowner the option to purchase the installed equipment.

B. TECHNICAL DISCUSSION....cont'd

2. Field Test Program - Testing Procedure for Home Test

The home test units were each tested with the furnace and retrofit unit operating normally. As illustrated in Figure 2, the following measurements were recorded:

(a) Ambient temperature of the air in the furnace room.

(b) Temperature of the flue gas at the draft hood outlet, with dilution air (Location 1).

(c) Temperature of the flue gas at the retrofit unit outlet, in the PVC vent pipe near the furnace (Location 2).

(d) Temperature rise of the air across the retrofit coil, taken from the return air plenum above the retrofit unit (Location 3) to the connecting collar between the retrofit unit and furnace (Location 4).

(e) Temperature rise of the air through the furnace, taken from the connecting collar between the retrofit unit and furnace (Location 4) and the supply air plenum above the furnace (Location 5).

(f) Total temperature rise of the air through the retrofit and furnace taken from the return air plenum (Location 3) to the supply air plenum (Location 5).

(g) Percentage of Carbon Dioxide in the flue gas, measured at the retrofit outlet in the PVC pipe (Location 2).

(h) Efficiency of the total system.

An additional test was done on the installations that were still connected to the original venting system. With the retrofit package inoperative and the flue pipe damper removed, the furnace was operated in the conventional manner. The flue gases were once again vented to the original vent system. The following measurements were recorded as shown in Figure 3:

(a) Ambient temperature of the air.

(b) Temperature of the flue gas at the draft hood outlet, with dilution air (Location 1).

(c) Temperature rise of the air through the furnace, taken between the return air duct (Location 2) and the supply air duct (Location 3). This is also the total temperature rise of the system since the retrofit package is inoperative and does not affect temperatures.

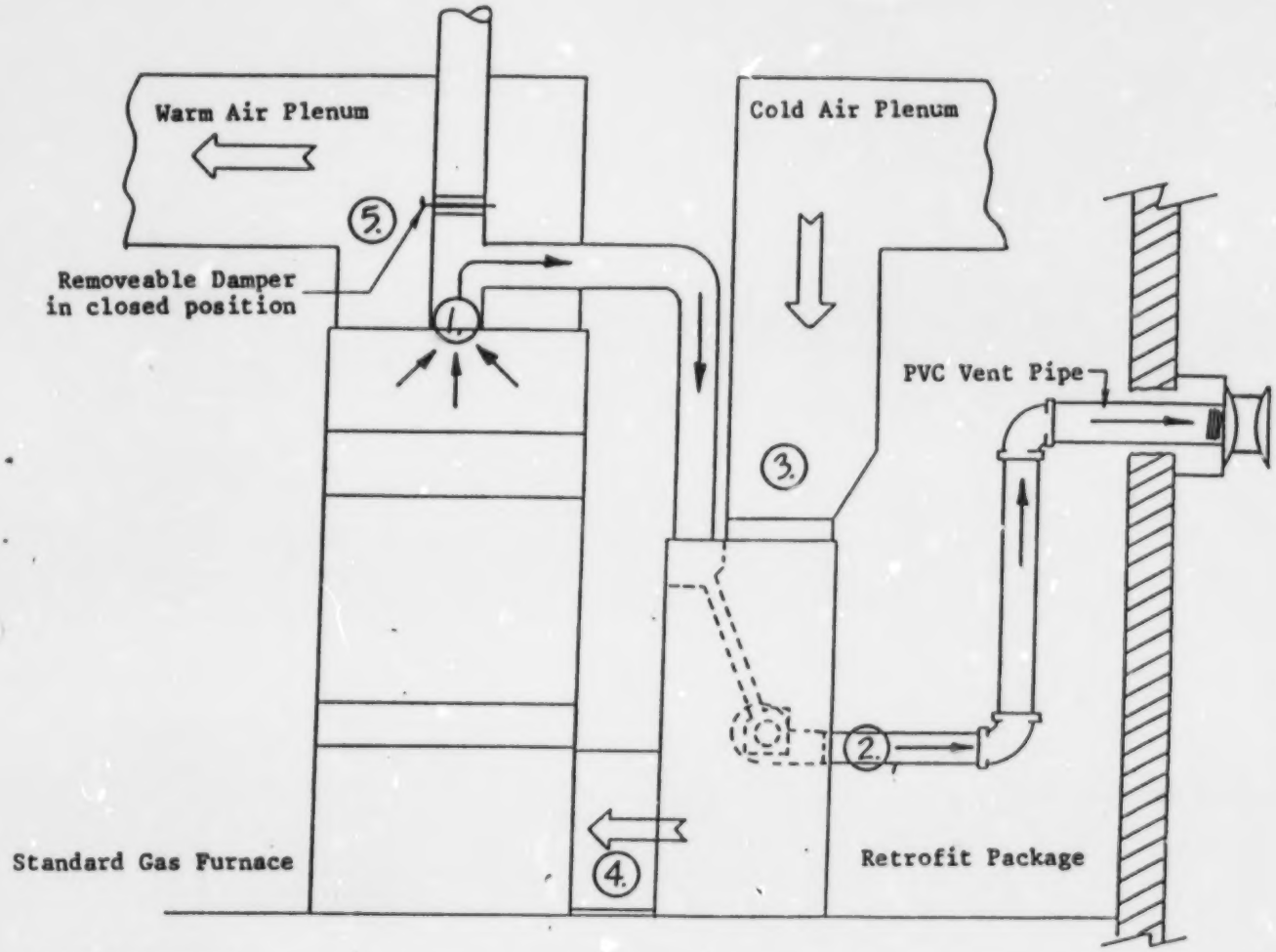
(d) Percentage of Carbon Dioxide in the flue gas measured at the draft hood outlet with dilution air (Location 1).

(e) Steady state efficiency of the furnace.

Measurements of Carbon Dioxide percentages and efficiencies were obtained using a Portable Efficiency Meter, Model C, produced by R.A.B. Dedesco Ltd.

FIGURE 2

TEST OF FURNACE AND RETROFIT COMBINATION

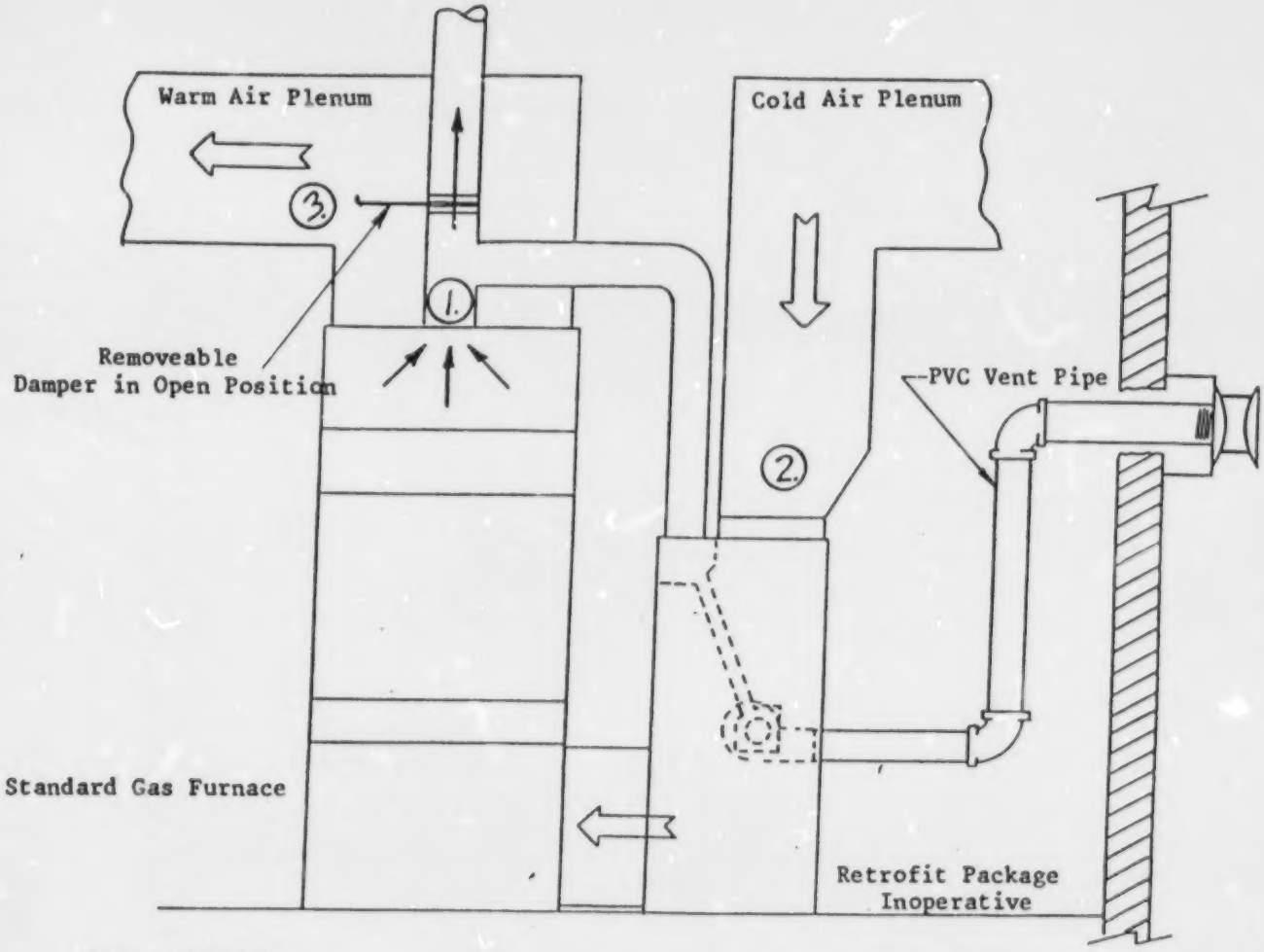


TEST LOCATIONS

1. Draft Hood Outlet - Flue Gas Temp. (With dilution air).
2. Retrofit Flue Gas Outlet - Flue Gas Temp.
   - Carbon Dioxide Percentage
   - Efficiency
3. Return Air Temp.
4. Connecting Collar Air Temp.
5. Supply Air Temp.

FIGURE 3:

TEST OF FURNACE WITH RETROFIT NOT IN OPERATION



TEST LOCATIONS

1. Draft Hood Outlet - Flue Gas Temp. (with Dilution Air).
   - Carbon Dioxide Percentage
   - Efficiency

2. Return Air Temp.

3. Supply Air Temp.

B. TECHNICAL DISCUSSION....cont'd

3. Summary of Field Test Information

Field Installations: (S.P. - Standing Pilot, S.I. - Spark Ignition)

SITE NO.	NAME AND ADDRESS	UNITS	INSTALLATION DATE
1	Mr. Brian Bailey 43 Forest Glen Cr., Kitchener, Ontario.	Clare MBG 120 S.I. HEG-R 80,000	Nov. 22, 1982
2	Mr. Derek Spencer 122 Edward St., Cambridge, Ontario.	Clare MBG 60 S.I. HEG-R 80,000	Dec. 16, 1982
3	Mr. E. da Silva, 1260 Fairview Road, Cambridge, Ontario.	CLARE HBG 138 S.I. HEG-R 120,000	Dec. 17, 1982
4	Mr. Paul Perreault, 3 McCammon St., Paris, Ontario.	Olsen HBS-72 S.I. HEG-R-80,000	Dec. 20, 1982
5	Mrs. Charlotte Hushley 1047 Clare Ave., Cambridge, Ontario.	CLARE LBG 120 S.I. HEG-R-120,000	Dec. 22, 1982
6	Mr. Larry Cardoso, 1156 Michael Cres., Cambridge, Ontario.	Lennox 110 S.P. HEG-R-120,000	Dec. 23, 1982
7	Mrs. Nellie Coles, 1520 Concession Rd., Cambridge, Ontario.	Flame Master, 70 S.P. HEG-R-80,000	Jan. 7, 1983
8	Mr. Tony Figueiredo, 139 Bakersfield Drive, Cambridge, Ontario.	Olsen 105 S.P. HEG-R-120,000	Jan. 11, 1983
9	Mr. Dennis Wybrow 535 Church Street, Cambridge, Ontario.	Flame Master 105 S.P. HEG-R-120,000	Jan. 12, 1983
10	Mr. Ted Clare, 750 Rose Street, Cambridge, Ontario.	CLARE LBG 80 S.I. HEG-R-80,000	Jan. 27, 1983
11	Mr. D. Godfrey 20 Woodview Cres., Kitchener, Ontario.	Lennox G8D2 S.I. HEG-R-80,000	Jan. 31, 1983
12	Mr. R. Hollamby, 117 Sanford Fleming Dr., Waterloo, Ontario.	Preston 136 GLD-1 HEG-R-125,000	Oct. 12, 1983

SUMMARY OF TEST RESULTS

FURNACE AND RETROFIT

SITE NO.	FLUE GAS TEMP. - (°F)			AIR TEMP. RISE (°F)			CARBON DIOXIDE IN FLUE GAS (PERCENT)	STEADY STATE EFFICIENCY (PERCENT)
	AMBIENT	DRAFT HOOD OUTLET	RETROFIT OUTLET	ACROSS RETROFIT COIL	THROUGH FURNACE	TOTAL		
1	63	340	135	9	54	63	2.7	87.5
2	70	470	131	14	75	89	3.8	86.6
3	69	510	124	16	130	146	4.2	87.8
4	63	360	121	24	73	97	3.9	87.7
5	70	330	113	17	73	90	3.8	87.6
6	75	570	143	16	160	176	3.3	87.2
7	71	570	136	21	64	85	3.3	86.3
8	69	515	131	23	89	112	4.3	87.2
9	64	440	127	19	64	83	2.3	84.9
10	67	360	109	11	75	86	5.7	88.3
11	67	560	136	14	100	114	4.3	87.4
12	68	440	143	12	77	89	3.8	86.2

FURNACE (RETROFIT INOPERATIVE)

SITE NO.	FLUE GAS TEMP. (°F)		AIR TEMP RISE (°F) THROUGH FURNACE	CARBON DIOXIDE IN FLUE GAS (PERCENT)	STEADY STATE EFFICIENCY (PERCENT)
	AMBIENT	DRAFT HOOD OUTLET			
1	TEST NOT POSSIBLE				
2	71	365	82	2.7	73.0
3	69	330	120	2.7	73.0
4	63	190	85	1.4	75.0
5	70	305	91	3.3	74.4
6	75	550	170	2.8	68.0
7	74	380	65	2.8	70.0
8	70	500	125	3.9	75.0
9	64	435	72	2.6	67.0
10	67	275	73	3.7	78.7
11	67	430	97	2.5	75.7
12	TEST NOT POSSIBLE				

SUMMARY OF GAS SAVINGS

SITE NO.	TYPE OF FURNACE ORIGINALLY IN HOUSE		HEATING GAS USE (C.F/°F)		SAVINGS (PERCENT)
	COMPANY AND MODEL	HEAT EXCHANGER	BEFORE RETROFIT	RETROFIT	
1	Findlay 2H100 F9	Sect.	7.1	5.0	29.6
2	Clawsey Sohrt 100	Sect.	9.0	6.6	26.7
3	Clare HBG 138	Sect.	15.0	10.7	28.7
4	Clawsey Sohrt 90 GLB	Sect.	7.2	5.95	17.3
5	Clare LBG 102	Drum	9.4	7.7	18.1
6	Lennox G8-110T	Sect.	18.3	14.2	22.4
7	Clare G126 LB	Drum	11.0	7.7	30.0
8	Intercity HGD 100	Sect.	13.8	11.0	20.3
12	Clawsey Sohrt	Sect.	17.0	12.5	26.5

AVERAGE SAVINGS 24.4%

9	Clare Low Boy 110	Drum	12.4	11.3	9.1
10	Clare Low Boy 120	Drum	14.9	13.8	7.4
11	N/A		N/A		

INSTALLATIONS 9 & 10 WERE UNUSUAL INSTALLATIONS PRIOR TO RETROFIT AND RESULTS WILL BE REDONE NEXT SEASON ON A BASIS ON SWITCHING FROM RETROFIT TO NON RETROFIT MODE DURING THE SEASON. INSTALLATION 11 WILL BE MONITORED IN THE SAME WAY. THIS WAS A NEW HOME WITHOUT ANY ENERGY HISTORY.

B. TECHNICAL DISCUSSION

4. Installation and Operating Manual

During the course of the project much consideration has been given to the installation and operation manual that will be required for the commercialized product. Several considerations require that the manual be as simple, comprehensive and "fool-proof" as possible:

1) The standard retrofit package is intended to be applied to a range of furnaces with various inputs that have been produced by several Canadian manufacturers.

2) Existing heating/cooling systems will vary from one location to the next and must be addressed accordingly.

3) The Regulatory Authorities must be convinced that sufficient information has been supplied to the contractor in order that each furnace may be retrofitted in a safe and professional manner.

4) Installation/operating information must be available to the Utilities so that they are capable of inspecting and monitoring installations.

Based upon these criteria, it was decided to split the Manual up into three sections:

1) Pre-installation survey.
2) Installation instructions.
3) Operating sequence/malfunction checklist.

While a copy of the complete manual is attached (Appendix (c)), a brief discussion of each of the sections follows:

1) Pre-installation Survey:

The heating contractor must make a preliminary survey of the existing heating/cooling system in each proposed installation. He must determine whether or not the furnace is in good operational condition, whether the ductwork is of sufficient capacity, and whether the furnace blower is capable of producing the required air flow after the addition of the retrofit coil.

The required survey is quite simple to carry out using standard tools and instruments as detailed in the manual. The survey is similar to one that should be performed prior to the installation of a cooling unit.

Clare has placed a monitoring device in this part of the process by requiring the contractor to submit a copy of the pre-installation survey back to the factory. This will be a necessary condition of obtaining warranty on the equipment.

If the installation meets the criteria specified, the contractor is free to proceed with a retrofit; if it does not, the Manual specifies that a Retrofit Package should not be installed.

B. TECHNICAL DISCUSSION

4. Installation and Operation Manual...cont'd

2) Installation Instructions:

Installation instructions are spelled out in complete detail including the use of diagrams. A note-worthy aspect of the installation is that provision is made to be able to switch the furnace back to its original mode of operation (using a "T" flue pipe, damper and an electric switch on the retrofit units). A 1/2" square inch relief opening is standard in the tee damper supplied with the retrofit for use with furnaces having standing pilots.

3) Operating Sequence/Malfunction Check List

Clare Brothers has endeavoured to cover off all conceivable operating and failure modes that the system would encounter in the field and has provided a list of checks to be made to resolve any field problems that may arise.

In summary, Clare Brothers has put together an Installation/Operation Manual that puts as much information as possible into the hands of Contractors, Utilities and Regulatory Bodies.

5. Induced Draft Fan Design

Design and operating characteristics of the induced draft fan were seen to be a very high priority early on in the initial project. A fan was required to provide sufficient air flow and static to clear furnaces with inputs of 60,000 to 125,000 BTU/hr without any draft hood spillage. As well, the fan components were required to withstand a slightly corrosive operating environment as a result of the furnace flue gases being slightly acidic.

Initial design and testing was hampered since no suppliers could be found that were currently producing fans of the required specifications. Early designs incorporated a stainless steel housing and fan wheel. However, it was impossible to adequately seal the housing, resulting in condensate leaking out of the fan housing. Further investigation resulted in housings and wheels being protected with a plastic P.V.C. coating. While this coating provided sealing and good corrosion resistance, it caused noise and vibration problems in the fan assembly. Due to the complex shape of the fan wheel, it was virtually impossible to get a uniform coating applied. Despite the fact that each wheel was statically balanced, the operating characteristics in the retrofit unit were not satisfactory.

As well, the units utilized a separate "transition box" between the fan outlet and the P.V.C. exhaust pipe. This transition was used primarily to provide a location for a condensate drainage tube and a pressure tap. Even with the use of a closed-cell neoprene gasket between the fan outlet and the transition box, several of the units developed condensate leaks. As a result of the above problems, further design and testing was performed to arrive at a solution.

B. TECHNICAL DISCUSSION

5. Induced Draft Fan Design...con't

The present fan design (see drawing-Figure 1) reflects all changes that have been made. The separate transition box has been eliminated, the drainage and pressure taps having been relocated into the fan housing proper. While the plastic P.V.C. coating has been retained on the fan housing, the wheels have now been specified to be finished with a black phosphate coating. Extensive checks on these wheels over the past two heating seasons has shown the coating to the impervious to the effect of the flue gases.

To further enhance the performance of the fan assemblies, Clare Brothers purchased (not as part of this contract) a piece of vibration monitoring equipment. Each assembly can be tested to ensure operation is within prescribed limits.

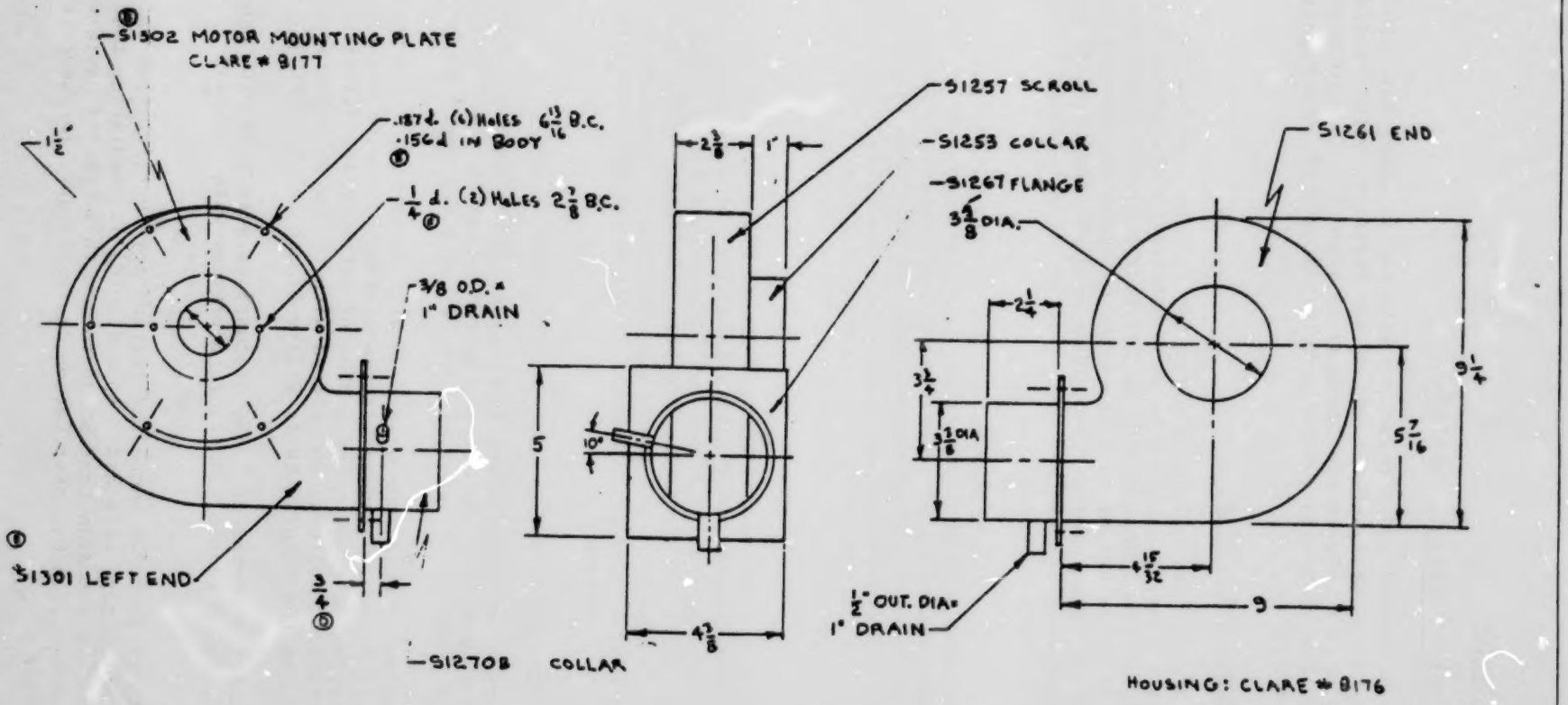
A further complication of the fan design was the necessity of having one fan which would satisfy a range of furnace inputs. The problem has been resolved by providing several different sized "discs" to be placed in the fan inlet and at the tertiary heat exchanger inlet. The disc sizes are dictated by the input of the existing furnace, as detailed in the Installation Manual. Three inch diameter plastic P.V.C. piping is specified for use in venting the retrofit unit. Again, after extensive testing, 3" diameter pipe was found to satisfy the venting requirements of furnaces in the 60,000 to 125,000 BTU/hr. input range.

6. Pressure Control Design

Design, laboratory and field test work performed on Clare Megasave I high efficiency gas furnaces showed that safety interlocks were required due to the complexity of design and operation of the units. The application of a separate retrofit unit to existing furnaces made these safety devices even more important. Initial designs employed the use of two adjustable Penn pressure controls. One control (low-normally open) was employed to ensure that sufficient static had been created by the indirect draft fan to clear the unit before allowing combustion to take place. A second control (high-normally closed) was employed to ensure that specified venting lengths had not been exceeded or that obstruction had not been placed in the vent system.

As with several other components used in the initial retrofit designs, the early pressure switches were not designed for the specific application. This resulted in switches that were expensive and lacking the required features. Experience in the Megasave I furnace had shown the adjustable pressure switches were all too easily tampered with in the field.

Clare Brothers worked with a U.S. supplier, Tridelta Industries of Mentor, Ohio, to obtain suitable switches. The present switches are much less sensitive to the effects of vibration and flue gas condensation and are factory set and sealed. Clare engineers then started testing to enable one pressure switch to be used instead of two.



REV.	CHANGES	BY	DATE
D	[illegible]	DG	[illegible]
C	S1261, S1270A [illegible] WAS S1211, S1270	DG	JAN 83
B	S1301, S1302 WAS S1251, S1260	DG	[illegible]
A	STEEL TUBBING WAS COPPER	DG.	SEPT 82

SCALE: 1/3
ADDITIVE FINISH: SEE NOTE
HEAT TREATMENT: —
GUIDE: —
PROJECT NO: 82 43
SUPERSEDES:
SUPERSEDED BY:

ITEM	DESCRIPTION	MAT'L OR REF.
DESIGN	DG JAN 83	FOR:
DRAWN	DG JAN 83	DELHI INDUSTRIES LTD. DELHI, ONT.
CHK'D.		
APP'VD		

TOLERANCES EXCEPT WHERE NOTED
FRACTIONAL ± 1/32
DECIMAL ±
ANGULAR ±

CLARE VENT BLOWER HEHB SERIES
90500 15 D

SEPT 2/83

FIGURE 1: INDUCED DRAFT FAN

B. TECHNICAL DISCUSSION

6. Pressure Control Design...Cont'd

Further testing and interaction with the supplier has resulted in a safe system employing the use of one pressure switch reading negative pressure between the tertiray coil and the induced draft fan. This same system is currently being integrated into Megasave I furnace designs.

7. Heat Exchanger Coil Design

The original retrofit prototypes employed heat exchangers of "Unifin" type tubes positioned between fabricated stainless steel headers. The "Unifin" tubes (manufactured by Keeprite Ltd.) were one inch (1") diameter, 18 gauge stainless steel tubes with radial aluminum fins affixed to the tubes. While these tubes produced the required heat transfer characteristics, they were limiting from a design standpoint and were also very expensive.

Working with Bohn Heat Transfer Co. of Danville, Illinois, Clare Brothers purchased several prototypes heat exchangers of a "slab" design normally used in air conditioning applications. Early experimentation with 1/2" diameter tubes had proven unsuccessful; further testing was carried out with a coil employing 1" I.D. stainless steel tubes. Experimentation with internal turbulator baffles, various aluminum fin spacings and the number of tubes resulted in a viable coil design.

Based upon these tests, Clare Brothers had a specialized fin die and fin line manufactured by Tridan Industries of Danville, Illinois. This equipment has been received and is presently also being used to manufacture coils for the Clare Megasave I furnaces. The redesign of the heat exchanger coil and subsequent decision to manufacture in-house has resulted in a sizeable reduction in the total manufacturing cost of the retrofit package.

C. APPROVALS STATUS

At the time of writing, Clare Brothers still has not been successful in obtaining the necessary approvals required to market the finalized retrofit unit in Canada. A brief history of the steps taken to date follows:

- Many individual discussions were held with personnel of the Ontario Fuels Safety Branch, Canadian Gas Association and Union Gas Limited, to gain approval for a limited number of retrofit installations in Central Ontario. Approval to proceed with twelve installations was granted by the Ontario Fuels Safety Branch on December 17, 1982.

- During the early months of 1983, discussions were held with Canadian Gas Association personnel in order to proceed with Canadian certification.

- Clare Brothers formally requested testing for certification on April 22, 1983 (copy attached - Appendix (d)). Realizing that there was no existing Canadian test standard for this type of equipment, a copy of the American Gas Association draft standard for heat reclaimers was attached.

C. APPROVALS STATUS...cont'd

- On April 27, 1983 we were advised in writing by C.G.A. that no action would be taken until the matter was placed before the next meeting of the Interprovincial Gas Advisory Council. Clare Brothers had discussions with C.G.A. in an attempt to have a Clare representative make a presentation at the I.G.A.C. meeting.

- Mr. E. C. Clare made a brief presentation at the I.G.A.C. meeting in Banff, Alberta on May 16, 1983 (copy attached - Appendix (d)). The council moved a motion requesting C.G.A. to review the Clare Retrofit Package and report on its effect on the certification of the original installed furnace. (excerpt from June 29, 1983 minutes attached - Appendix (d)).

- Since the motion made by I.G.A.C. did not resolve the question of certification, Clare Brothers asked C.G.A. to make a technical evaluation of the unit on June 20, 1983. A unit was sent to C.G.A.. Several tests were performed and C.G.A. sent back a report on August 9, 1983. Copy attached - Appendix (d).

- On August 17, 1983, after having made minor design changes to the Retrofit, Clare Brothers again formally requested C.G.A. to test and certify the unit.

- On August 22, 1983, a delegation of Clare personnel held a meeting with personnel of C.G.A. in an attempt to get the certification process going. It was decided that Clare Brothers should proceed with a complete information package including a proposed Installation Manual which would be presented to I.G.A.C.

- During the Fall and Winter of 1983, several further discussions were held with various C.G.A. personnel, but no progress was made in starting the certification process.

- During the same period of time Clare Brothers applied to the American Gas Association Laboratories for design certification of the Retrofit unit in the United States. A substantial back log of units awaiting test at A.G.A. has delayed testing until May 1984.

- In early 1984, Clare Brothers rewrote the Retrofit Installation and Operating Manual in an attempt to get the process going. The Manual was forwarded to C.G.A. personnel. On April 2, 1984, a pre-test deposit was forwarded to C.G.A. as requested.

- On April 28, 1984 another Retrofit unit was delivered to the C.G.A. labs during a meeting held between Clare Brothers and C.G.A. personnel.

- During this meeting Clare Brothers was advised that C.G.A. personnel would be addressing the question of "retrofits" at the upcoming I.G.A.C. meeting in June, 1984. C.G.A. personnel suggested that Clare Brothers make up an information package which C.G.A. could send out to the I.G.A.C. members prior to the meeting. During the meeting, several criteria were discussed as a means of controlling types of retrofits that I.G.A.C. might consider. C.G.A. personnel indicated that they

C. APPROVALS STATUS...cont'd

- would be proposing that retrofits meeting the following criteria be tested by C.G.A. labs using special test procedures:

  1. Furnaces to be retrofitted must meet current Standard CAN 1-2.3 (i.e. not possible to retrofit furnaces that have already been converted (burner, etc.,), furnaces with induced draft fans or vent dampers.)

  2. Temperature of the flue product leaving the retrofit must be 150°F. or less. (ensures the use of plastic pipe).

  3. Retrofit must be in the circulating air system of the original furnace (as the evaporator coil of a central A/C system).

  Clare Brothers is in complete agreement with the position being presented by C.G.A. At the present time Clare Brothers personnel are completing the information package and intending to request permission to speak at the I.G.A.C. meeting.

- It is our hope that with the information that is currently available, I.G.A.C. will direct C.G.A. to test the Clare Retrofit unit under applicable sections of the interim High Efficiency Furnace Standard.

- As of this date, A.G.A. has completed an analysis of the mechanical construction of the Retrofit unit and are in the process of performing laboratory tests. Ongoing discussions with A.G.A. personnel indicate that design certification will be forthcoming at the conclusion of the testing and description phases.

D. CONCLUSIONS AND RECOMMENDATIONS

Clare Brothers has successfully designed, developed and field tested a Retrofit Package for residential gas furnaces which will substantially reduce the energy consumption of existing residential gas furnaces.

The package will allow contractors to retrofit gas furnaces with inputs from 60,000 BTU/hr to 125,000 BTU/hr.

Initial design concerns related to the induced draft fan, pressure switches and heat exchanger coil have been addressed and resolved.

The technology advanced is a natural extension of condensing high efficiency furnace technology that has now been used successfully for several heating seasons. Clare Brothers were pioneers in this technology and in fact, were the first company to commercialize units in this category.

It is sincerely hoped that the Canadian regulatory bodies will allow Clare Brothers to introduce the proven design and reduced energy requirements of the Clare Retrofit Package to the Canadian market place.

APPENDIX (b)

FIELD TEST AGREEMENTS

Ontario
Ministry of Consumer and Commercial Relations
Fuels Safety Branch
Technical Standards Division

3300 Bloor Street West
Shipp Centre - West Tower
4th Floor
Toronto, Ont. M8X 2X4

(416) 239-1297

December 17, 1982
File: #1000

Clare
223 King St.,
Cambridge, Ontario
N3H 4T5

Attention: Mr. E.C. Clare, P.Eng.
Vice President Engineering.

Dear Mr. Clare:

Subject: Retrofit Project Re Secondary Heat Exchangers Forced Warm Air Furnaces

The above subject was discussed with the Branch Director Mr. H.T. Jones. Mr. Jones asked that I contact you to confirm acceptance of the test program with respect to twelve (12) installations of the above equipment.

The acceptance is granted subject to

(1) Twelve (12) installations only as detailed in your letter of November 15.

(2) C.G.A. Inspection Personnel inspect all units and installations.

(3) Monitoring of all units by Clare personnel.

(4) Program will be reviewed after a period of one year.

Yours truly,

A. Allan,
Chief Inspector.

AA/bh

cc: All Inspectors
T.A.C. Gas

Ontario Ministry of Consumer and Commercial Relations

Technical Standards Division

Fuels Safety Branch

Sixth Floor
Ste. Centre - West Tower
4th Floor
Toronto, Ont. M8X 2X4

(416) 239 - 1279

November 22, 1983
File: 1000

Clare Bros.
223 King Street
Cambridge, Ontario
N3H 4T5

Attention: Mr. E.C. Clare, P. Eng.
Vice President Engineering

Dear Mr. Clare:

Subject: Retrofit Project Re Secondary Heat Exchangers Forced Warm Air Furnaces

Further to my letter of December 17th, 1982 with respect to the above subject.

This letter will confirm the additional six installations that were agreed upon in December.

The acceptance is granted subject to:

(1) C.G.A. Inspection Personnel inspect all units and installations.

(2) Monitoring of all units by Clare personnel.

(3) Program will be reviewed after a period of one year.

Yours truly,

A. Allan

AA/jmcl

A. Allan
Chief Inspector

cc: All Inspectors
T.A.C. Gas

APPENDIX (a)

APPROVALS DOCUMENTS - FIELD TEST

THIS AGREEMENT made in duplicate as of the 6th day of October 1983.

BETWEEN: Clare Brothers, a body corporate with offices at 223 King Street, Cambridge, Ontario (hereinafter called "the Contractor")

OF THE FIRST PART

AND Mr. Russ Hollamby, 117 Sanford Fleming, Waterloo, Ontario. residing at

hereinafter called "the" Homeowner")

OF THE SECOND PART

WITNESSETH THAT:

WHEREAS the Contractor will carry out an evaluation of a system comprising of a gas-fired furnace retrofitted with condensing heat exchangers (hereinafter called "the System"); and

WHEREAS the Contractor is carrying out this program under contract with Her Majesty the Queen in right of Canada (hereinafter called "her Majesty") as represented by the Minister of Supply and Services (hereinafter called "the Minister"); and

WHEREAS the Homeowner has agreed to allow the Contractor to install, monitor and evaluate the system;

NOW, THEREFORE, in consideration of mutual covenants, agreements and obligations contained in this agreement, the parties mutually covenant and agree as follows:

1. The System shall be installed at the Homeowner's residence located at 117 Sanford Fleming, Waterloo, Ontario (hereinafter called "the Building"), and the Homeowner agrees that the System shall remain installed at the Building for one year commencing from the date of installation thereof which is to be determined by the Contractor.

2. In the event of the subsequent sale, assignment or disposition of the Building or of any interest therein, the Homeowner shall exact similar commitments as contained in this Agreement from the subsequent owner or successors in title.

3. Installation of the System shall be carried out by the Contractor or its represenatives. Necessary approvals and permits shall be obtained by he Contractor with the assistance of the Homeowner when necessary, from appropriate municipal and provincial officials. In the event that necessary approvals and permits cannot be obtained, then the Agreement shall be null and void.

4. For up to one year after the System is installed at the Building, the Homeowner shall permit the contractor, its subcontractors and authorized representatives, Her Majesty, Her Servants, employees and authorized representatives to enter the Building at all reasonable times: a) to install the System, b) monitor the performance of the System, c) maintain and make repairs to the System, to photograph the installed System and generally do those things which are consistent with the efficient operation of the System and the promotion of the retrofit condensing heat exchangers. The Contractor and representatives of Her Majesty shall notify the Homeowner before each visit to the installation.

5. After one year from the date of installation, the Contractor agrees to remove all equipment owned by Her Majesty unless the Homeowner agrees in writing to purchase the System from the Contractor at the same price as the contractor purchases it from Her Majesty, less the cost of removal. Such purchase shall exclude any monitoring equipment and shall exclude any instruments which are not necessary for the operation of this System.

6. Subsequent to the completion of the monitoring program or the removal of the equipment owned by Her Majesty or the sale thereof to the Homeowner, the Contractor shall have no further obligations of any kind to the Homeowner.

7. The Homeowner shall take reasonable and proper care of the System at all times. The Homeowner shall not willfully or negligently damage the System or allow any damage or injury to be caused to the System. The Homeowner shall be responsible for any loss or damage to the System and for any loss or damage to instruments for monitoring the performance of the System resulting from his failure to take reasonable and proper care of the System. However, the Homeowner shall not be responsible for loss or damage due to force majeure or circumstances beyong the Homeowner's reasonable control.

8. The Homeowner shall permit the Contractor or Her Majesty to use the Homeowner's name, moving and still photographs of the Building and the Homeowner's family, testing results obtained at the Building and other information about the Homeowner's experience with the System in publications, broadcasts, films, releases to the media, and in any other reasonable way. This shall be done at any time after installation, without payment to the Homeowner. The telephone number and street address of the Homeowner shall not be disclosed without the consent of the Homeowner.

9. It is agreed between the Parties that Her Majesty is the owner of the System and the monitoring equipment and the Homeowner shall have no rights therein until and unless the System becomes the property of the Homeowner.

10. It is agreed between the Parties that no representation, warranty or collateral agreement of any kind whatsoever, express or implied, is given by Her Majesty with regard to the existence, operation or maintenance of the System or the monitoring equipment.

11. It is agreed between the Parties that Her Majesty shall not be liable for any damage or injury of any kind whatsoever resulting from the existence, installation, operation or maintenance of the System and the monitoring equipment.

IN WITNESS WHEREOF, Clare Brothers has affixed its seal duly attested by the hands of its duly authorized signing officers in that behalf and the Homeowner has duly executed this Agreement.

SIGNED, SEALED AND DELIVERED
in the presence of

Clare Brothers

(Homeowner)

APPENDIX (c)

RETROFIT INSTALLATION/OPERATION MANUAL

Clare

MEGASAVE I

INSTALLATION AND OPERATION MANUAL

MODEL HEG-R RETROFIT

THIS MANUAL MUST BE LEFT WITH THE FURNACE FOR FUTURE REFERENCE.

CLARE BROTHERS — CAMBRIDGE, ONTARIO

THE CLARE MEGASAVE RETROFIT - DEALER PRELIMINARY SURVEY

THE CLARE MEGASAVE RETROFIT UNIT IS A PACKAGE THAT CAN BE ADDED TO A STANDARD GAS FURNACE AND SIGNIFICANTLY IMPROVE THE PERFORMANCE. THE EFFICIENCY WILL IMPROVE FROM THE 60% LEVEL OF MOST CONTEMPORARY GAS FURNACES UP TO THE 90% LEVEL.

THE UNIT MUST BE INSTALLED IN THE RETURN AIR SYSTEM BEFORE THE AIR ENTERS THE FURNACE. THE HOMEOWNER'S EXISTING FURNACE IS NOT CHANGED IN ANY WAY DURING THE INSTALLATION EXCEPT FOR THE ADDITION OF A SPILLAGE CONTROL.

THE HEATING CONTRACTOR MUST MAKE A PRELIMINARY SURVEY OF THE EXISTING SYSTEM IN THE HOME. HE MUST DETERMINE WHETHER OR NOT THE FURNACE IS A SATISFACTORY UNIT, WHETHER THE DUCTWORK SYSTEM IS OF SUFFICIENT CAPACITY, AND WHETHER THE FURNACE BLOWER IS CAPABLE OF PRODUCING THE REQUIRED AIR FLOW WITH THE ADDITION OF THE RETROFIT COIL.

SOME DUCTWORK SYSTEMS HAVE BEEN UNDERSIZED SINCE THE ORIGINAL INSTALLATION WAS MADE. OTHERS HAVE BEEN PUSHED TO THEIR CAPACITY WHEN A COOLING UNIT HAD BEEN ADDED.

THE REQUIRED SURVEY IS QUITE SIMPLE TO CARRY OUT AND IS A NECESSARY CHECK BEFORE THE APPLICATION OF A CLARE MEGASAVE RETROFIT UNIT. IT IS IDENTICAL TO THE SURVEY THAT SHOULD BE MADE PRIOR TO THE INSTALLATION OF A COOLING UNIT. A COPY OF THE DEALERS SURVEY MUST BE RECEIVED BY THE COMPANY BEFORE THE WARRANTY BECOMES EFFECTIVE.

THE SYSTEM IS CHECKED BY DETERMINING IF AN AIR TEMPERATURE RISE THROUGH THE SYSTEM OF 85°F CAN BE ATTAINED WITH RATED INPUT.

CLARE BROTHERS MEGASAVE HEG-RETROFIT INSTALLATION SURVEY SHEET

STEP 1 — INSPECTION OF EXISTING FURNACE

MANUFACTURER AND MODEL No.		INPUT	
FAN SIZE		BLOWER PULLEY	
MOTOR PULLEY			
TYPE OF PILOT	STANDING	ELECTRIC	
ARE THERE SIGNS OF CORROSION			
ARE THERE SIGNS OF LEAKAGE			

DO NOT RETROFIT IF THERE ARE SIGNS OF LEAKAGE OR CORROSION

DATE OF FURNACE INSTALLATION		
HAS SYSTEM BEEN HEATING HOME ADEQUATELY		

DO NOT RETROFIT IF ORIGINAL HEATING SYSTEM HAS NOT BEEN HEATING THE HOME TO THE CUSTOMERS SATISFACTION

STEP 2 — FINDING THE INPUT AND OUTPUT OF THE EXISTING FURNACE

SECONDS	60	59	58	57	56	55	54	53	52	51
CUBIC FEET	60	61	62	63	64	65	67	68	69	71
SECONDS	50	49	48	47	46	45	44	43	42	41
CUBIC FEET	72	73	75	77	78	80	82	84	86	88
SECONDS	40	39	38	37	36	35	34	33	32	31
CUBIC FEET	90	92	95	97	100	103	106	109	113	116
SECONDS	30	29	SECONDS = METER TIMING FOR 1 CUBIC FT. OF GAS							
CUBIC FEET	120	124	CUBIC FT. = CUBIC FEET OF GAS PER HOUR							

METER CHART

-TIME THE GAS METER IN SECONDS TO FIND THE TIME FOR 1 CUBIC FOOT OF GAS - WHILE THE FURNACE ONLY IS OPERATING. SELECT THE APPROPRIATE DIAL ON THE METER FOR THIS TIMING.

-FROM THE METER CHART - READ THE INPUT IN CUBIC FEET OF GAS PER HOUR. TAKE AT LEAST 2 READINGS.

E.G. IF YOU TIMED 45 SECONDS FOR 1 CUBIC FOOT YOU WILL READ 80 CUBIC FEET OF GAS PER HOUR - INPUT TO THE FURNACE

-80 CUBIC FEET PER HOUR = 80 000 BTUH

-TO DETERMINE THE OUTPUT OF THE FURNACE MULTIPLY THE INPUT X 3/4. IN THE ABOVE EXAMPLE THE OUTPUT IS 80 000 X 3/4 BTUH. = 60 000 BTUH

TIME FOR 1 CUBIC FOOT OF GAS	SECONDS	
INPUT IN CUBIC FEET PER HOUR - FROM CHART	CUBIC FEET	
INPUT TO UNIT = CUBIC FEET PER HOUR X 1000	BTUH	
OUTPUT TO UNIT = INPUT X 3/4	BTUH	

THE INPUT SHOULD AGREE CLOSELY WITH NAMEPLATE RATING

STEP 3 — AIR VOLUME OF THE SYSTEM

- -THE TEMPERATURE RISE THROUGH THE SYSTEM MUST BE 85°F OR LESS BEFORE A RETROFIT PACKAGE IS ADDED
- -CONTINUE TO OPERATE THE UNIT AFTER TIMING THE METER. AFTER 10 MINUTES TAKE A TEMPERATURE READING IN A MAIN WARM AIR TRUNK DUCT-12" FROM THE PLENUM AND IN A RETURN DUCT.

TEMPERATURE OF WARM AIR	°F
TEMPERATURE OF RETURN AIR	°F
TEMPERATURE RISE	°F

- -IF THE TEMPERATURE RISE EXCEED 85°F CHANGE TO A SMALLER FAN PULLEY OR LARGER MOTOR PULLEY. ON A DIRECT DRIVE FAN CHANGE TO A HIGHER SPEED TAP
- -IF UNABLE TO BRING TEMPERATURE DOWN TO 85°F RISE DO NOT RETROFIT

OTHER GAS EQUIPMENT CAN BE OPERATING WHEN DETERMINING AIR TEMPERATURE RISE THROUGH THE UNIT.

DO NOT RETROFIT A FURNACE WITH
(a) A CLOSED 3½ V.S. MOTOR PULLEY X 5" BLOWER PULLEY
(b) A DIRECT BLOWER CONNECTED TO ITS HIGHEST SPEED
UNLESS THE RISE THROUGH THE UNIT IS 75°F OR LESS AS DETERMINED IN STEP 3.

STEP 4 — ADD ON COOLING UNITS

- -THERE ARE OCCASIONS WHEN AN ADD ON COOLING UNIT WILL PREVENT THE EFFICIENT APPLICATION OF A RETROFIT PACKAGE
- -IF THE FURNACE HAS BEEN OVERSIZED FOR THE HOME AND THE COOLING UNIT SIZED PROPERLY THE COOLING COIL COULD RESTRICT THE SYSTEM 80°F TEMPERATURE RISE OR BELOW 80°F.
- -THE FOLLOWING CHART WILL INDICATE WHEN A RETROFIT PACKAGE MUST NOT BE CONNECTED

FURNACE INPUT BTUH	FURNACE OUTPUT BTUH	CFM @ 80 F RISE	MINIMUM COOLING UNIT SIZE
60 000	45 000	525	1½ TON
70 000	52 500	610	1½ TON
80 000	60 000	700	2 TON
90 000	67 500	785	2 TON
100 000	75 000	870	2 TON
110 000	82 500	960	2½ TON
120 000	90 000	1045	2½ TON

-DO NOT RETROFIT A FURNACE EQUIPPED WITH ADD-COOLING IF THE COOLING UNIT IS SMALLER THAN THAT SHOWN AGAINST THE NAMEPLATE RATING IN THE ABOVE CHART

COOLING UNIT MAKE AND MODEL No.	RATING
	Tons

STEP 5	CHECKING THE BLOWER MOTOR -IT IS IMPORTANT THAT THE BLOWER MOTOR IS NOT OPERATING OVER THE RATED AMPERAGE SHOWN ON THE RATING PLATE. -USING A CLAMP ON AMMETER AROUND 1 ELECTRIC LEAD TO THE MOTOR. READ THE MOTOR CURRENT. _____ AMPS

FINAL TEST AFTER RETROFIT COMPLETED

REPEAT STEP 3	TEMPERATURE OF WARM AIR SUPPLY	^{o}F
	TEMPERATURE OF RETURN AIR	^{o}F
	TEMPERATURE RISE THROUGH THE UNIT	^{o}F
	TEMPERATURE RISE SHOULD NOT EXCEED $90^{o}F$	
REPEAT STEP 5	AMPERAGE DRAW ON NAMEPLATE OF MOTOR	AMPS
	AMPERAGE DRAW READ BY AMMETER	AMPS
	MOTOR SIZE	HP
	MOTOR PULLEY SIZE _____ FAN PULLEY SIZE _____	

THIS SURVEY MUST BE COMPLETED AND A COPY SUBMITTED WITH WARRANTY APPLICATION.

HEATING CONTRACTOR

STREET ADDRESS

CITY POSTAL CODE

CUSTOMER NAME

STREET ADDRESS

CITY POSTAL CODE

Clare

MODEL MEG-R RETROFIT - MEGASAVE I

GENERAL REQUIREMENTS

(1) ALL INSTALLATIONS MUST BE IN ACCORDANCE WITH THE CAN 1-B149.1&2, LOCAL CODES AND MANUFACTURERS INSTRUCTION MANUAL.

(2) THE RETROFIT SECTION MAY BE INSTALLED ON EITHER SIDE OF THE EXISTING FURNACE AS SHOWN ON DIAGRAM ON PAGE 13. 6 INCH CLEARANCE FROM COMBUSTIBLES IS REQUIRED FROM THE FLUE PIPE THAT CONNECTS THE EXISTING FURNACE TO THE RETROFIT SECTION AND FROM THE TOP RIGHT AREA OF THE RETROFIT SECTION. ALL OTHER AREAS CAN HAVE A ZERO CLEARANCE. A MINIMUM DISTANCE OF 18 INCHES MUST BE ALLOWED FROM THE FRONT OF THE RETROFIT SECTION FOR SERVICE ACCESS.

(3) WIRING TO BE RUN BETWEEN THE EXISTING FURNACE AND THE RETROFIT SECTION SHALL CONFORM WITH THE TEMPERATURE LIMITATIONS OF TYPE T WIRE 63°F (35°C) RISE WHEN INSTALLED IN ACCORDANCE WITH THESE INSTRUCTIONS.

INSTALLATION INSTRUCTIONS (REFER TO DIAGRAMS ON PAGES 13, 14 & 15)

(1) REMOVE SHIPPING CARTON AND CAREFULLY CHECK FOR ANY DAMAGE OCCURED THROUGH SHIPPING. REPORT ANY CLAIMS IMMEDIATELY TO THE LAST CARRIER.

(2) DETERMINE DESIRED UNIT LOCATION AND KEEP IN MIND SERVICE REQUIREMENTS, ELECTRICAL, CONDENSATE AND VENT PIPE CONNECTIONS THAT ARE REQUIRED.

(3) DISCONNECT THE RETURN AIR DUCTWORK CONNECTION FROM THE EXISTING FURNACE AND POSITION RETROFIT SECTION. ATTACH THE R.A. DUCTWORK WITH THE REQUIRED TRANSITIONS TO THE DUCTWORK CONNECTION AT THE TOP OF THE RETROFIT SECTION.

(4) KNOCKOUTS ARE PROVIDED AT THE BOTTOM OF EACH SIDE PANEL OF THE RETROFIT SECTION TO ALLOW A MINIMUM OPENING OF 14 IN. BY 15 IN. FOR THE DUCT CONNECTION BETWEEN THE RETROFIT SECTION AND THE MAIN BLOWER COMPARTMENT OF THE EXISTING FURNACE.

NOTE: WHEN THE RETROFIT SECTION IS LOCATED ON THE LEFT SIDE OF THE EXISTING FURNACE A MINIMUM DISTANCE OF 8 INCHES IS REQUIRED BETWEEN THE RETROFIT SECTION AND EXISTING FURNACE TO ALLOW FOR VENT PIPING.

Clare

(5) FOR EFFICIENCY ADJUSTMENTS EACH MODEL HEG-R IS SUPPLIED WITH FOUR PRESSURE DISCS AS FOLLOWS:

1-4" O.D. - 1 7/8" I.D.
1-4" O.D. - 2 1/4" I.D.
1-3½"O.D. - 1 3/4" I.D.
1-3½"O.D. - 2" I.D.

THE 4" O.D. SIZE WHEN REQUIRED IS INSERTED IN THE INLET COLLAR OF THE RETROFIT SECTION AND SEALED IN WITH A BEAD OF SILICONE CAULKING.

THE 3½" O.D. SIZE WHEN REQUIRED IS INSERTED IN THE VENT FAN INLET RUBBER COUPLING AND SEALED IN WITH A BEAD OF SILICONE CAULKING.

THE DISCS ARE USED ACCORDING TO THE FOLLOWING TABLE:

GAS INPUT B.T.U./HOUR	RETROFIT INLET DISC	VENT FAN INLET DISC
60,000-80,000	4" O.D. X 1 7/8" I.D.	3½" O.D. X 1 3/4" I.D.
80,000-100,000	4" O.D. X 2 1/4" I.D.	3½" O.D. X 2" I.D.
100,000-125,000	NO DISC REQUIRED	NO DISC REQUIRED

(6) DISCONNECT THE FLUE PIPE FROM THE EXISTING CHIMNEY AND BLOCK OFF THE CHIMNEY. RUN FLUE PIPE FROM THE EXISTING FURNACE CONNECTION TO THE RETROFIT SECTION FLUE INLET. REDUCING TO 4" DIA. AS SHOWN.

(7) CONNECT 115 VOLT ELECTRICAL SUPPLY ACCORDING TO THE ENCLOSED WIRING DIAGRAM AND IN ACCORDANCE WITH LOCAL CODES.

(8) CONNECT THE LOW VOLTAGE WIRING BETWEEN THE RETROFIT SECTION AND THE EXISTING FURNACE AS SHOWN ON THE ENCLOSED WIRING DIAGRAM.

(9) THE THERMAL SPILLAGE SWITCH IS SUPPLIED AS AN ADDITIONAL SAFETY MEASURE TO BE MOUNTED BY THE INSTALLER AT THE RELIEF OPENING OF THE DRAFT HOOD ON THE EXISTING FURNACE USING THE MOUNTING BRACKETS SUPPLIED. SEE DIAGRAM ON PAGE 16.

Clare

(10) CONNECT THE CONDENSATE DRAIN AS SHOWN ON PAGE 15. THE DRAIN PIPE MUST BE A MINIMUM OF ½" INSIDE DIA. AND OF ANY PLASTIC PLUMBING MATERIAL SUCH AS GARDEN HOSE, P.V.C., ABS, ETC.
DO NOT USE METALLIC PIPING FOR DRAIN. IF DRAIN CANNOT BE SLOPED NATURALLY TO WASTE WATER CONNECTION A CONDENSATE PUMP CAN BE USED. IF THE PUMP IS LOCATED INSIDE THE UNIT THE EXISTING HEIGHT OF THE TRAP AND OVERFLOW MUST NOT BE ALTERED.

VENTING REQUIREMENTS

REFER TO DIAGRAMS ON PAGE 14 OF THESE INSTRUCTIONS. VENT MATERIAL: 3 INCH NOMINAL DIAMETER P.V.C. OR A.B.S. PIPE. PIPE AND FITTINGS THICKER THAN SCHEDULE "40" SHALL NOT BE USED.

THE VENT TERMINATION SHALL NOT BE LOCATED:

(a) LESS THAN 18 INCHES ABOVE THE FINISHED GRADELINE.
(b) LESS THAN 1 FOOT FROM ANY BUILDING OPENING.
(c) LESS THAN 3 FEET FROM THE COMBUSTION AIR INLET OF ANY OTHER APPLIANCE.
(d) DIRECTLY ABOVE A GAS UTILITY METER OR SERVICE REGULATOR.
(e) LESS THAN 18 INCHES FROM ANY BUILDING PROJECTION SUCH AS AN EXISTING OUTSIDE CHIMNEY.

THE VENT PIPING SHALL SLOPE DOWNWARDS FROM THE TERMINATION TO THE RETROFIT SECTION A MINIMUM OF ¼ INCH PER RUNNING FOOT.

ALL VENT PIPING SHALL BE ADEQUATELY SUPPORTED EVERY 5 FEET TO PREVENT SAGGING. CONDENSATE COULD COLLECT IF VENT PIPING IS ALLOWED TO SAG. VENT PIPING MUST NOT RUN THROUGH UNHEATED AREAS UNLESS INSULATED.

LENGTH OF VENTING

THE MAXIMUM ALLOWABLE VENT PIPE LENGTH IS 110 EQUIVALENT FEET.
FOR EACH 90° ELBOW ALLOW 15 EQUIVALENT FEET.
FOR EACH 45° ELBOW ALLOW 5 EQUIVALENT FEET.

Clare

PIPING INSTALLATION

CUT ALL VENT PIPING AT A RIGHT ANGLE. CLEAR INSIDE AND OUTSIDE BURR AT EACH CUT TO PERMIT SMOOTH INSERTION INTO THE FITTING SOCKET. USE CLEANER AND CLEAN PIPE AND FITTING SOCKET. USE C.S.A. LISTED CEMENT TO FASTEN PIPE AND FITTINGS. FOLLOW CLEANING AND CEMENTING INSTRUCTIONS CAREFULLY TO AVOID LEAKAGE. IF A MIX OF P.V.C. AND A.B.S. PIPE AND FITTINGS ARE USED AN APPROVED TYPE OF TRANSITION CEMENT MUST BE USED.

(1) STRAIGHT THROUGH TERMINAL (REFER TO DIAGRAM ON PAGE 14)

ALLOW THE VENT PIPE TO PROTRUDE THROUGH THE OUTSIDE WALL 1½ INCHES. CEMENT 3 INCH COUPLING TO THE WIND TERMINATION SLIDE TERMINAL BOX AND WIND TERMINATION ASSEMBLY ONTO THE VENT PIPE AND MARK LAG SCREW LOCATIONS. DRILL AND INSERT LAG SLEEVES. REMOVE TERMINAL ASSEMBLY AND PACK CAREFULLY WITH FIBREGLASS TO KEEP THE VENT TERMINAL AS WARM AS POSSIBLE. APPLY CAULKING CEMENT TO THE WALL EDGES OF THE TERMINAL BOX. CLEAN AND CEMENT VENT PIPE AND COUPLING SOCKET. LAG TERMINATION ASSEMBLY TO WALL AND RECAULK ALL EDGES.

(2) RISER TERMINAL (REFER TO DIAGRAM ON PAGE 14)

BRING THE VENT PIPE THROUGH THE WALL AND FLUSH WITH THE OUTSIDE WALL. ALLOW SPACE AROUND THE VENT TO ACCOMMODATE AN ELBOW. CUT REQUIRED LENGTH OF PIPE FOR VENT RISER. FIT LOWER ELBOW, VENT PIPE RISER LOOSELY TOGETHER WITH VENT TERMINAL. CHECK POSITION FOR VENT TERMINATION BOX. MARK AND DRILL LAG SCREW POSITION AND INSERT SLEEVES. CLEAN AND CEMENT UPPER ELBOW TO TERMINAL NIPPLE AND VENT RISER PIPE. CLEAN AND CEMENT LOWER ELBOW TO VENT RISER PIPE. PACK TERMINAL BOX WITH FIBREGLASS. CAULK WALL EDGES OF TERMINAL BOX. CLEAN AND CEMENT LOWER ELBOW TO FURNACE VENT PIPE AND LAG TERMINAL BOX TO WALL. ALLOW TIME TO DRY. PACK FIBREGLASS BETWEEN WALL AND VENT RISER. FIT RISER COVER IN POSITION AND MARK LAG SCREW POSITIONS. DRILL AND INSERT LAG SLEEVES. PACK RISER COVER WITH FIBREGLASS AND CAULK WALL EDGES. LAG COVER TO WALL AND RECAULK ENTIRE ASSEMBLY.

(3) THROUGH THE ROOF VENTING (REFER TO DIAGRAM ON PAGE 14)

ON SOME INSTALLATIONS IT MAY BE DESIRABLE TO RUN THE VENT PIPE UP THROUGH THE ROOF. THE MAXIMUM VENT LENGTH MUST NOT EXCEED THE TOTAL EQUIVALENT FEET AS SPECIFIED FOR THROUGH THE WALL VENTING.

Clare

(3) THROUGH THE ROOF VENTING - Continues

THE TERMINAL BOX USED WITH WALL VENTING CAN BE DISCARDED AND ELBOW TERMINATION ONLY USED AS SHOWN.

INSULATE THE VENT PIPE WHERE IT RUNS THROUGH UNHEATED OR ATTIC AREAS WITH A MINIMUM OF 2 INCH FIBREGLASS.

WHERE THE VENT PIPE PASSES THROUGH THE ROOF, IT MUST BE FLASHED AND SEALED TO PREVENT LEAKS.

A MINIMUM DISTANCE OF 12 INCHES MUST BE ALLOWED BETWEEN THE VENT TERMINATION AND THE ROOF.

(4) VENTING INSIDE AND EXISTING CHIMNEY (SEE DIAGRAM ON PAGE 14)

ON SOME INSTALLATIONS IT MAY BE DESIRABLE TO RUN THE VENT PIPE INSIDE AN EXISTING UNUSED CHIMNEY.

THE CHIMNEY MUST NOT BE USED FOR THE VENTING OF ANY OTHER APPLIANCE.

THE TOP OF THE EXISTING CHIMNEY MUST BE SEALED OFF TO PREVENT THE ENTRY OF RAIN OR SNOW.

THE TERMINAL BOX USED WITH WALL VENTING CAN BE DISCARDED AND ELBOW TERMINATION ONLY USED AS SHOWN.

VENT TESTING

BEFORE LIGHTING BURNERS WITH GAS CONTROL TURNED "OFF", ACTIVATE THE VENT FAN AND CHECK ALL JOINTS WITH A SOAP SOLUTION.

Clare

SEQUENCE OF OPERATION

WHEN ALL ASPECTS OF THE INSTALLATION ARE COMPLETED THE INSTALLING CONTRACTOR SHOULD CHECK OUT THE CORRECT SEQUENCE OF OPERATION AS FOLLOWS:

(1) EXISTING THERMOSTAT CALLS FOR HEAT, 24 VOLT A.C. IS SUPPLIED TO HEATER ELEMENT OF TIME DELAY SEQUENCER.

(2) AFTER 1 TO 2 SECOND DELAY, THE FIRST CONTACTS ON SEQUENCER CLOSE AND THE COMBUSTION AIR BLOWER STARTS. THE PRESSURE SWITCH CONTACTS CLOSE.

(3) AFTER A FURTHER DELAY OF 15 TO 30 SECONDS (PRE-PURGE TIME) THE SECOND CONTACTS ON THE SEQUENCER CLOSE. THIS PROVIDES POWER ACROSS THE ORIGINAL THERMOSTAT CONNECTIONS OF THE EXISTING FURNACE AND STARTS BURNER OPERATION AND MAIN BLOWER OPERATION.

(4) THIS OPERATION WILL CONTINUE AS LONG AS THE FOLLOWING CONDITIONS ARE MET:
   (a) FURNACE PILOT BURNER AND MAIN BURNER REMAINS LIT.
   (b) THE PRESSURE IN THE VENT PIPE DOES NOT EXCEED THE SETTING ON PRESSURE SWITCH.
   (c) LINEAR LIMIT SWITCH DOES NOT SENSE OVER TEMPERATURE OR SPILLAGE AT THE DRAFTHOOD OF FURNACE.
   (d) TEMPERATURE AT FURNACE LIMIT CONTROL DOES NOT EXCEED SETTING.
   (e) THERMOSTAT CONTINUES TO CALL FOR HEAT.

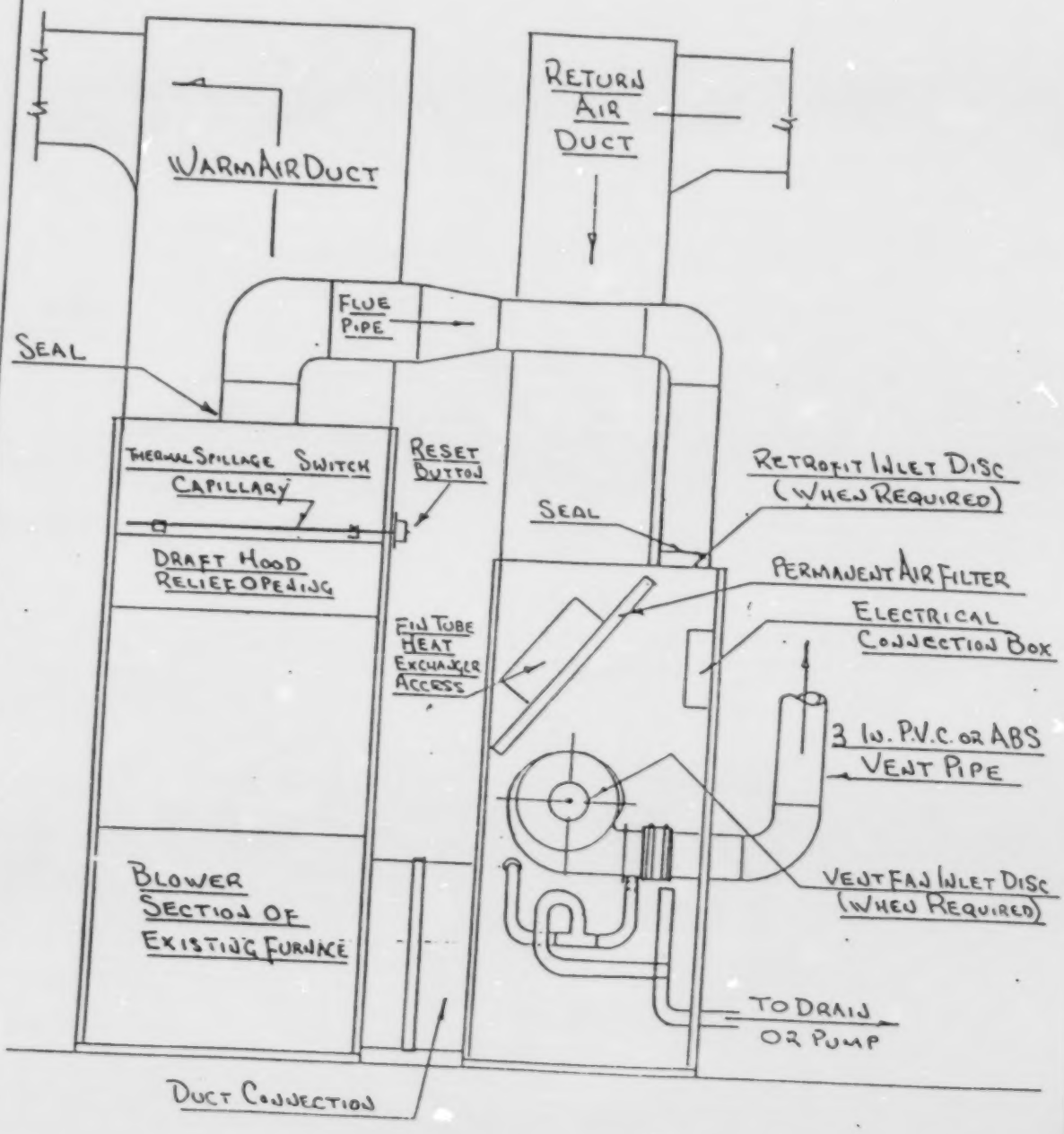
(5) WHEN THE THERMOSTAT IS SATISFIED, POWER TO HEATER ELEMENT OF SEQUENCER IS INTERRUPTED.

(6) AFTER A PRESET DELAY THE SECOND CONTACTS OF THE SEQUENCER OPEN AND GAS FLOW TO FURNACE BURNER IS INTERRUPTED.

(7) AFTER FURTHER DELAY (POST PURGE TIME) THE FIRST CONTACTS OPEN AND POWER TO THE COMBUSTION AIR BLOWER IS INTERRUPTED.

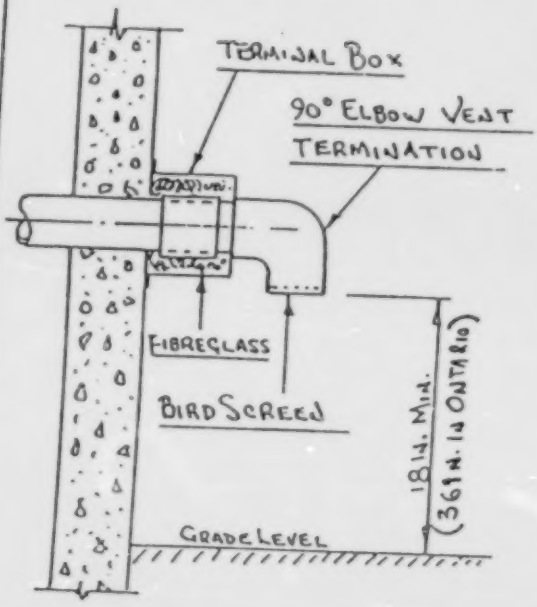
(8) THE MAIN BLOWER OF THE FURNACE WILL CONTINUE TO OPERATE UNTIL THE SETTING ON THE FURNACE BLOWER CONTROL IS REACHED.

Clare

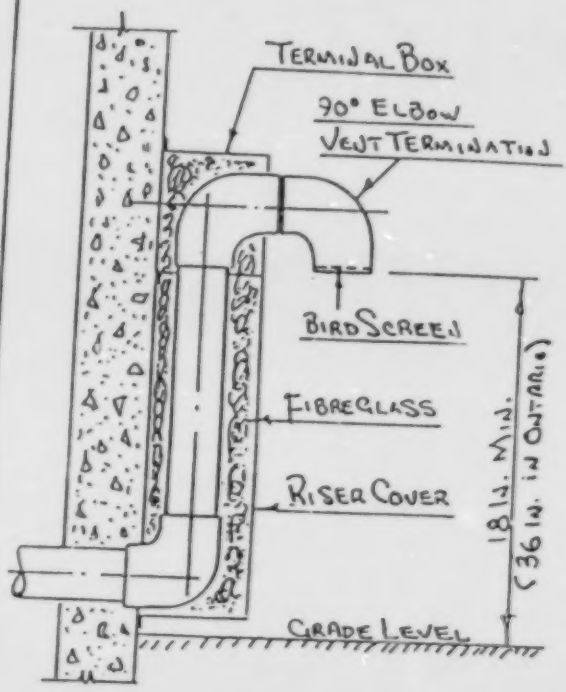


TYPICAL RETROFIT INSTALLATION

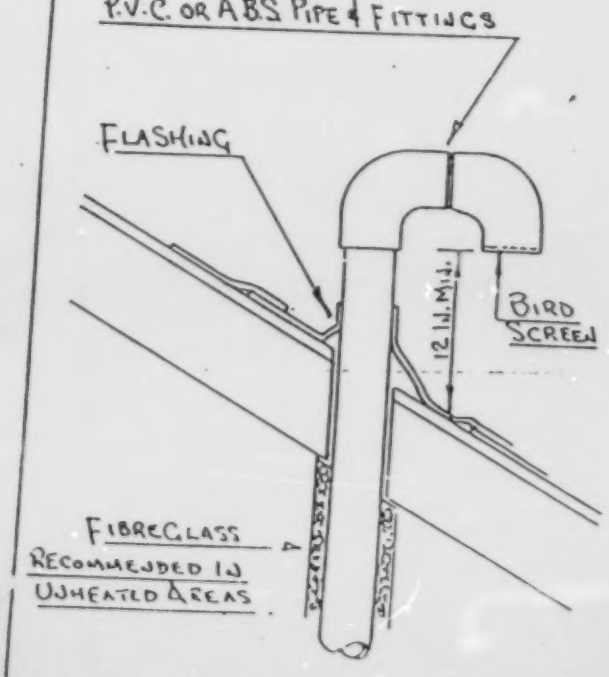
Clare



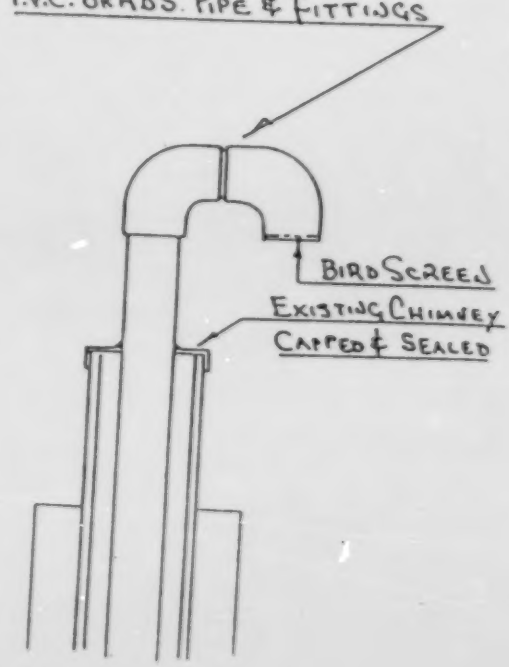
STRAIGHT THROUGH TERMINATION



"RISER" TERMINATION



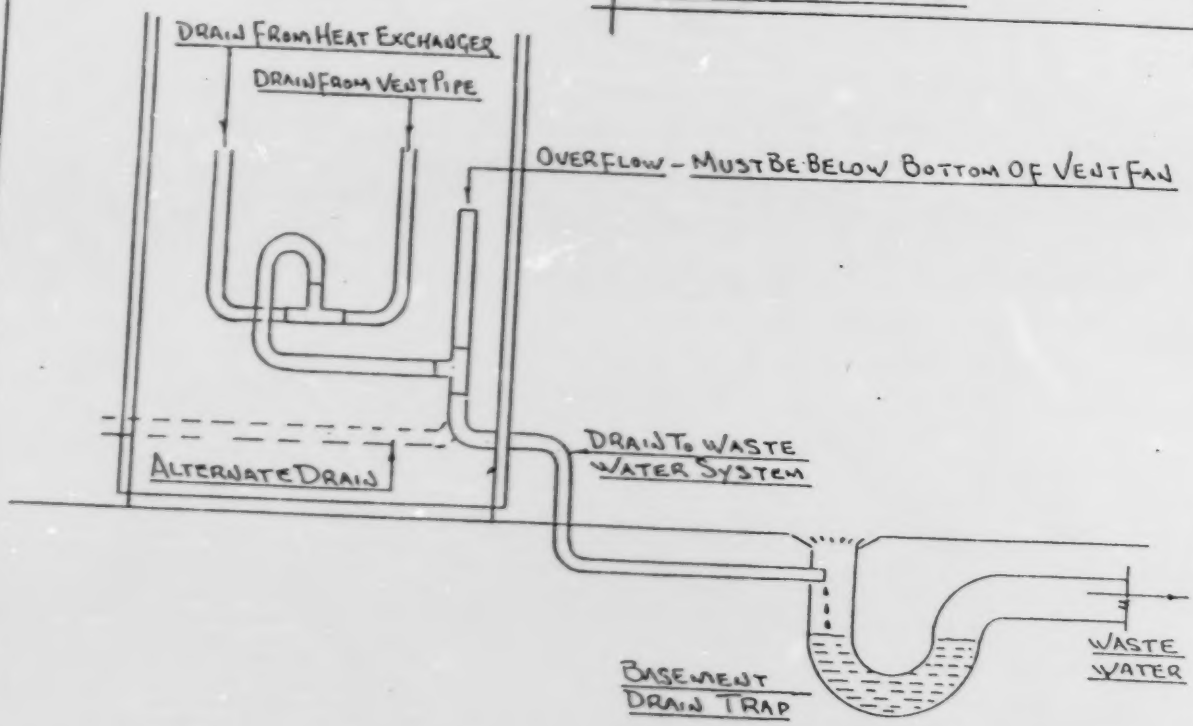
THROUGH THE ROOF VENTING



UP AN EXISTING CHIMNEY

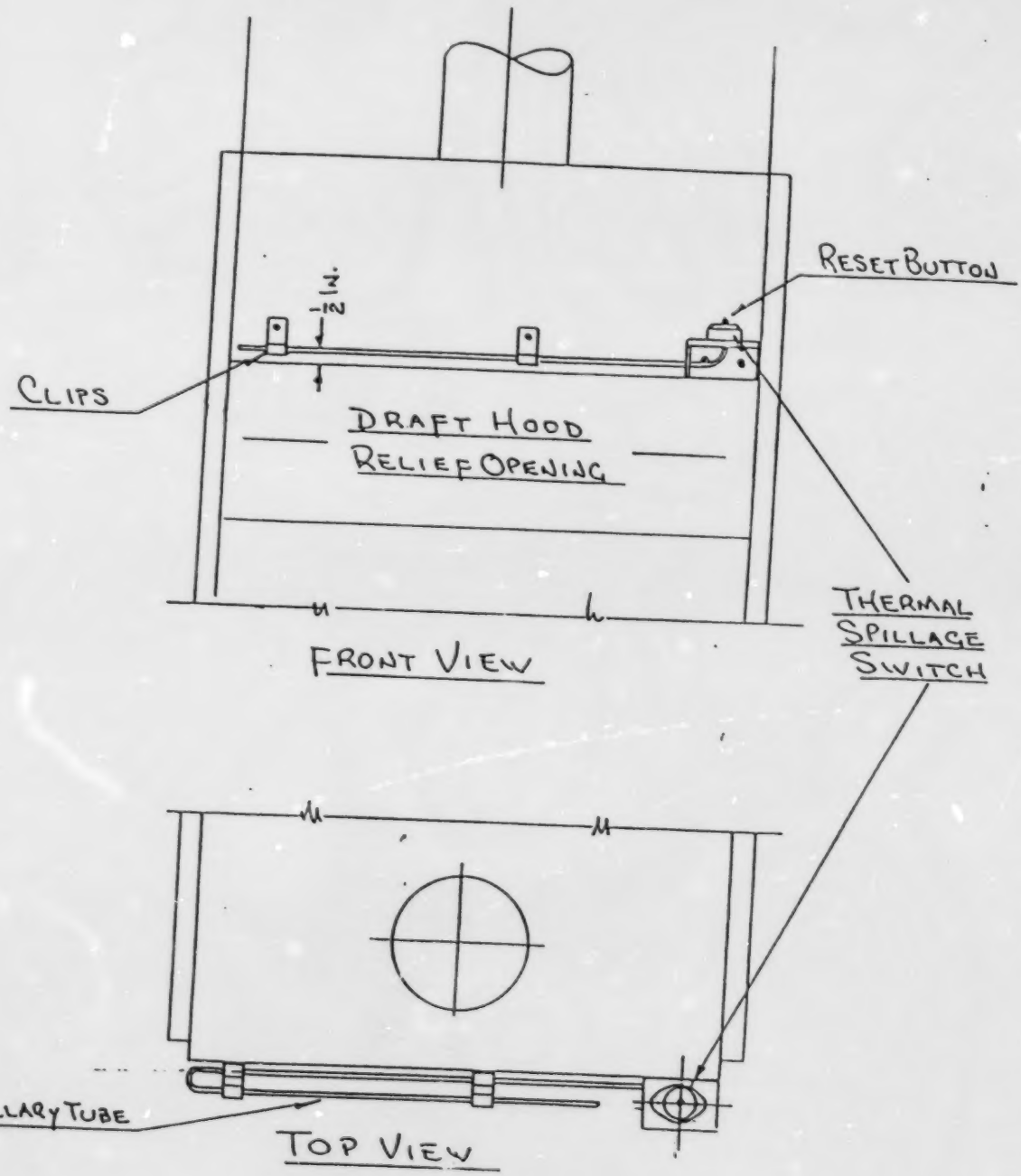
Clare

THERE MUST BE AN "AIR BREAK" BETWEEN THE DRAIN AND WASTE WATER SYSTEM AS SHOWN. DO NOT ENTER WASTE WATER SYSTEM AFTER TRAP. DRAIN PIPING MUST NOT RUN THROUGH UNHEATED AREAS UNLESS INSULATED.


DRAIN FROM HEAT EXCHANGER
DRAIN FROM VENT PIPE
OVERFLOW - MUST BE BELOW BOTTOM OF VENT FAN
ALTERNATE DRAIN
DRAIN TO WASTE WATER SYSTEM
BASEMENT DRAIN TRAP
WASTE WATER

TYPICAL DRAIN SYSTEM

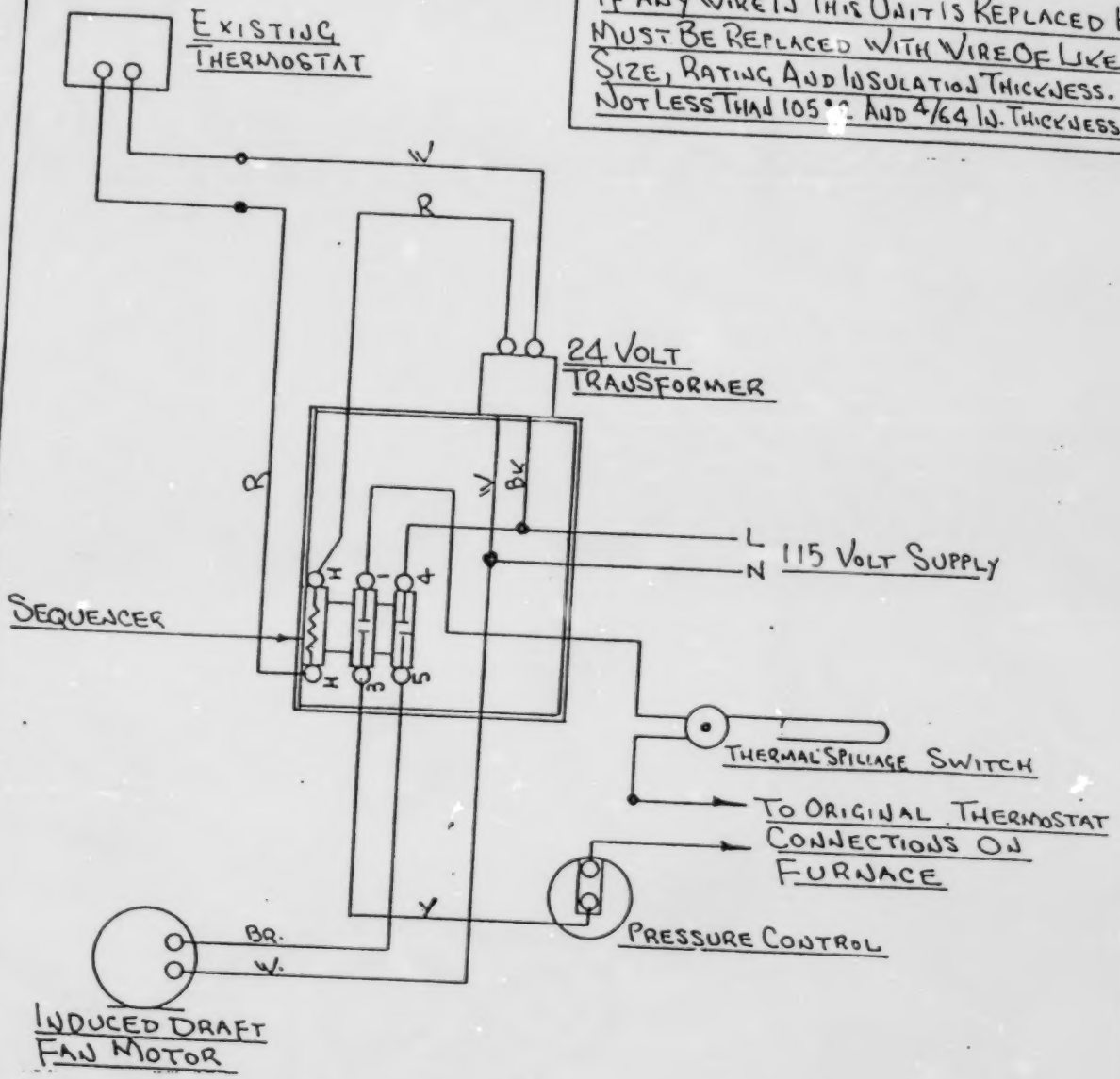
Clare



TYPICAL APPLICATION OF THERMAL SPILLAGE SWITCH ON EXISTING FURNACE

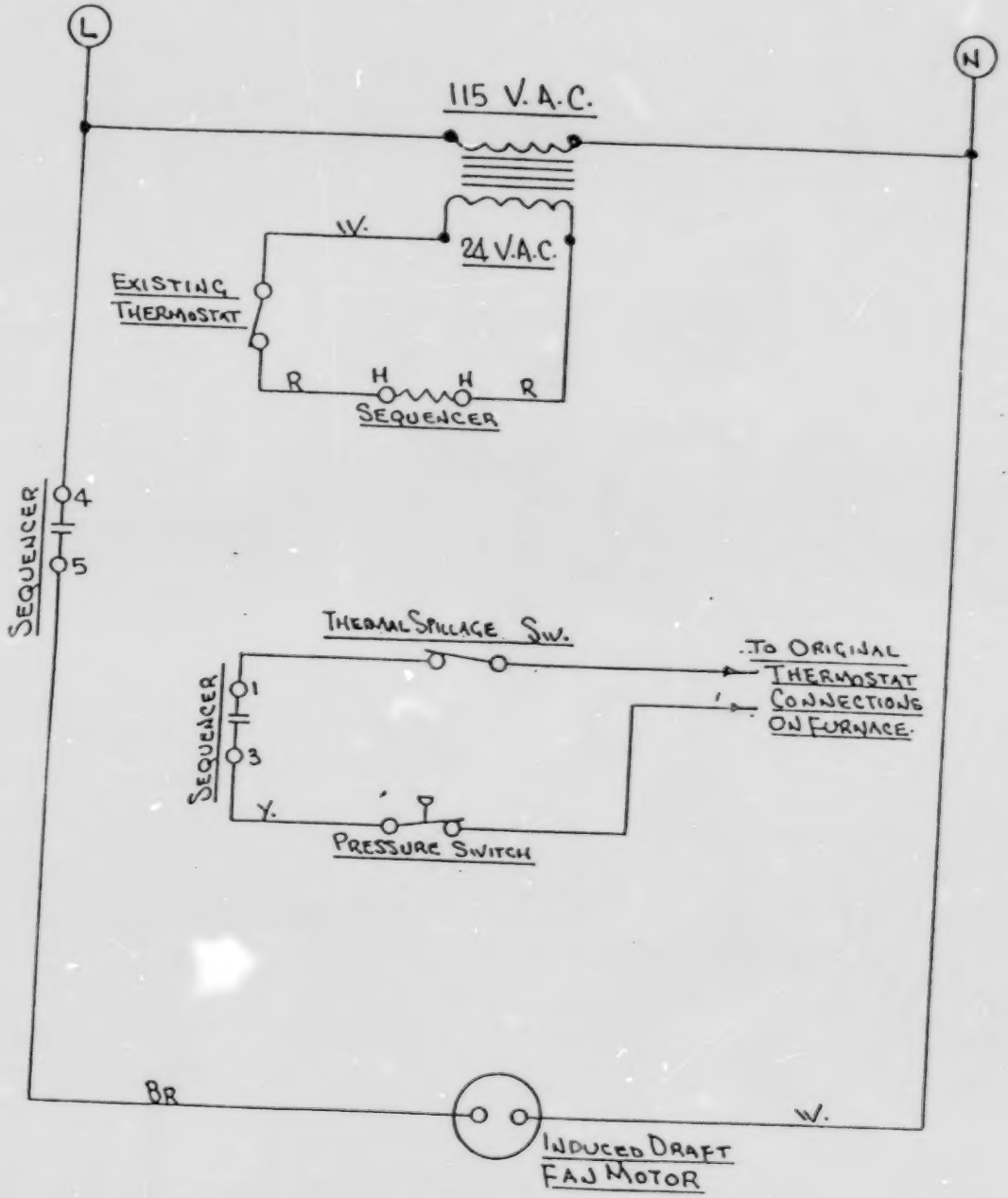
Clare

NOTE:
IF ANY WIRE IN THIS UNIT IS REPLACED IT MUST BE REPLACED WITH WIRE OF LIKE SIZE, RATING AND INSULATION THICKNESS. NOT LESS THAN 105°C AND 4/64 IN. THICKNESS.



MODEL H.E.G-R RETROFIT CONNECTION WIRING DIAGRAM

Clare



MODEL H.E.C.-R RETROFIT
SCHEMATIC WIRING DIAGRAM

APPENDIX (d)

APPROVAL RELATED DOCUMENTS- CANADIAN MARKET

Clare

223 King Street, Cambridge, Ontario N3H 4T5

April 22, 1983

Canadian Gas Association,
55 Scarsdale Road,
Don Mills, Ontario. M3B 2R3

Attention: Mr. E.Heeley

Dear Sir,

Enclosed is an "Application for Test" form for the certification of two sizes of high efficiency retrofit sections.

This section when installed with a standard gas furnace, allows a condensing operation and over 90% seasonal efficiency.

The proposed installation does not require any alteration to the approved gas furnace, with the possible exception of the application of a linear limit control to the existing draft hood.

We are presently running a field test program of 12 installations which is sponsored by the Federal Government and with the co-operation of the Union Gas Company and the Ontario Energy Branch. These installations have had a field inspection by Mr. Ted Turnbull (see enclosed photo's).

On these field installations, the existing vents were left in place with a manual slide damper installed to allow for normal operation in case of any malfunction.

Also enclosed are some descriptive drawings and a copy of the A.G.A. draft standard for heat reclaimers for possible guidance.

Yours truly,

CLARE BROTHERS

W. McCue, C.E.T.,
Engineering Division.

WMC/rds
Encls.

APPLICATION FOR TEST

CANADIAN GAS ASSOCIATION CERTIFICATION LABORATORY

55 Scarsdale Road, Don Mills, Ontario M3B 2R3

Please use one set of Applications for each type and/or series of appliances. One completed form should be returned to this office along with sufficient information to determine the actual test models.

Submitter: CLARE BROTHERS

Office and Mailing Address: 223 KING ST. W. CAMBRIDGE ONT. N3H 4T5

Correspondence directed to: W. McRUE C.E.T.

Invoices directed to: J. KOVACS P. ENG

Factory (Name and Address): ABOVE

Listee (Name and Address): ABOVE

Type of Appliance: HIGH EFFICIENCY RETROFIT SECTION - HEAT RECLAIMER ??

All models Requiring Listing	Type of Gas	0 – 2000 Feet Input Max.	0 – 2000 Feet Input Min.	0 – 2000 Feet Output	2000 – 4500 Feet Input Max.	2000 – 4500 Feet Input Min.	2000 – 4500 Feet Output
HEG-R-40-80	NAT or Prop	80 000	40,000	—			
HEG-R-40-120	" "	120 000	40,000	—			

PLEASE USE ADDITIONAL SHEET FOR SECOND FACTORY LOCATION, LISTEE OR EXTRA MODEL NUMBERS

MINIMUM CLEARANCES TO COMBUSTIBLES:

Top 0 Back 0" Left Side 0" Right Side 0" Front SERVICE 18"

TYPE OF FLOOR: Combustible ☒ Non-Combustible ☐

TYPE OF INSTALLATION: Alcove ☐ Closet ☐ Special Base Required Yes ☐ No ☒

TRADE NAME(S):

DISTRIBUTOR'S LISTING REQUIRED YES ☐ NO ☐

CHOICE OF LABORATORY LOCATION: C.G.A. Don Mills ☒ or B.C. Research ☐

FORWARD PARTICULARS PLEASE

Jim Kovacs
Signature

Engineering Manager
Title

JIM KOVACS P.ENG
Official's Name Printed

Canadian Gas Association

Association Canadienne du Gaz

April 27, 1983
File: Pending

Clare Bros. Ltd.,
223 King Street,
Cambridge, Ontario.
N3H 4T5.

Attention: Mr. W. McCue C.E.T.
Engineering Division.

Subject: Models HEG-R-40-(80,120) Heat Reclaimers.

Dear Sir:

This will acknowledge receipt of your letter dated April 22, 1983 and the enclosures regarding the subject units.

The question of whether we can certify this type of unit for retrofit will be brought up at the I.G.A.C. meeting on May 16, 1983. Therefore, we will withold any action with regards to your application until we know of the I.G.A.C. decision on this matter.

We trust that this details the position at this time and we will advise you further after the I.G.A.C. meeting.

Yours very truly,

CANADIAN GAS ASSOCIATION

G. H. Smith, Supervisor,
C.G.A. Certification Laboratory.

GS/jn

Clare

REPORT PRESENTED TO I.G.A.C. MEMBERS ON MAY 16, 1983

BY CLARE REPRESENTATIVE, MR. E. C. CLARE

223 King Street, Cambridge, Ontario N3H 4T5

May 13, 1983

On the 27th of March 1979 a meeting was convened in Ottawa by the Ministry of Energy Mines and Resources to discuss possibilities of improving the efficiency of existing gas furnace installations. Those invited and attending the meeting were staff members from Consumers Gas (1), Norcen (1), Union Gas (1), C.G.A. (2), Mr Lines, Chairman IGAC, Lennox (1), Honeywell (1), Clare (1), and E.M. & R. (4).

A Task Force was set up to prepare a list of retrofit proposals to be considered at a future meeting of the group.

A few weeks later, members of the heating industry were offered the data bank on high efficiency furnaces and the material requirements developed over a 4 year period by the Canadian Gas Research Institute. Clare had been active in the same field for some time and signed an agreement with C.G.R.I. for the available information. Our efforts on the high efficiency condensing furnace program were intensified.

The Ottawa meeting had triggered some rather innovative ideas by Clare for improving the efficiency on existing gas furnaces, based on this condensing furnace technology. An approach to E.M.&R. in the Spring of 79 with these suggestions, kindled significant enthusiasm with that group. We started an Engineering Program to develop a High Efficiency Converter for the existing furnace market. We have received and are continuing to receive funding assistance from the Federal Government.

. . . 2

4 Design Parameters Were Established For The High Efficiency Converter

1. The unit would not affect the C.G.A. approval of the unit in the home. It would not violate the installation code.

2. The unit would improve the overall combustion process safety factor.

3. There would be an attractive pay back period for the homeowner.

4. Most importantly, Clare recognized that venting problems were a serious concern at the time and would continue to plague the Inspection Authorities and Manufacturers in the future. We had to develop a unit that did not affect the existing home venting system.

Clare produced the first prototype by March 1981. The two units were tested by the Canadian Combustion Labratory group in 2 Ottawa homes in the 1981-82 season. Incidentally, a paper on the findings was presented at a World Symposium on Condensing Furnace Technology in Atlanta, Ga., in the Spring of 1982 by E.M. & R.

During the 1982-83 heating season we have installed and monitored 12 units which have converted a representative sampling of furnaces available to Canadians, from standard efficiency appliances, to units that have efficiencies in the +90% high efficiency condensing furnace range.

. . . ./3

Clare

The final product has remained within the original design parameters.

1. The converter does not violate the C.G.A. approval on the original unit or the installation code.

2. The linear limit monitoring of draft hood spillage is a significant improvement in safety - particularly for installations in confined areas.

3. The converter has its own venting system of 2" PVC plastic pipe and avoids all venting problems.

4. The seasonal efficiency is +90% and the payback is excellent.

5. Clare has developed an installation manual that will provide all necessary information for the safe and efficient installation of the converter.

The Clare Megasave Converter is in essence, a Power Venting System with the added advantage of saving at least 1/3 of the energy requirement for the home. The Converter will make a significant contribution to Canada's future energy conservation efforts.

The existing unit must have an integral draft hood. Under test code CAN 1-2.3 - M82 and Section 2.23.1, the unit passed a block flue test without carbon monoxide presence in the flue products. In addition, we supply a linear limit to be installed on the existing furnace draft hood to interrupt burner operation in the event of spillage occurring.

. . . ./4

The Converter complies with the appropriate section of the same code under 2.4 covering Power Venting. The Converter complies with the interim code on high efficiency furnaces in the section on Power Venting.

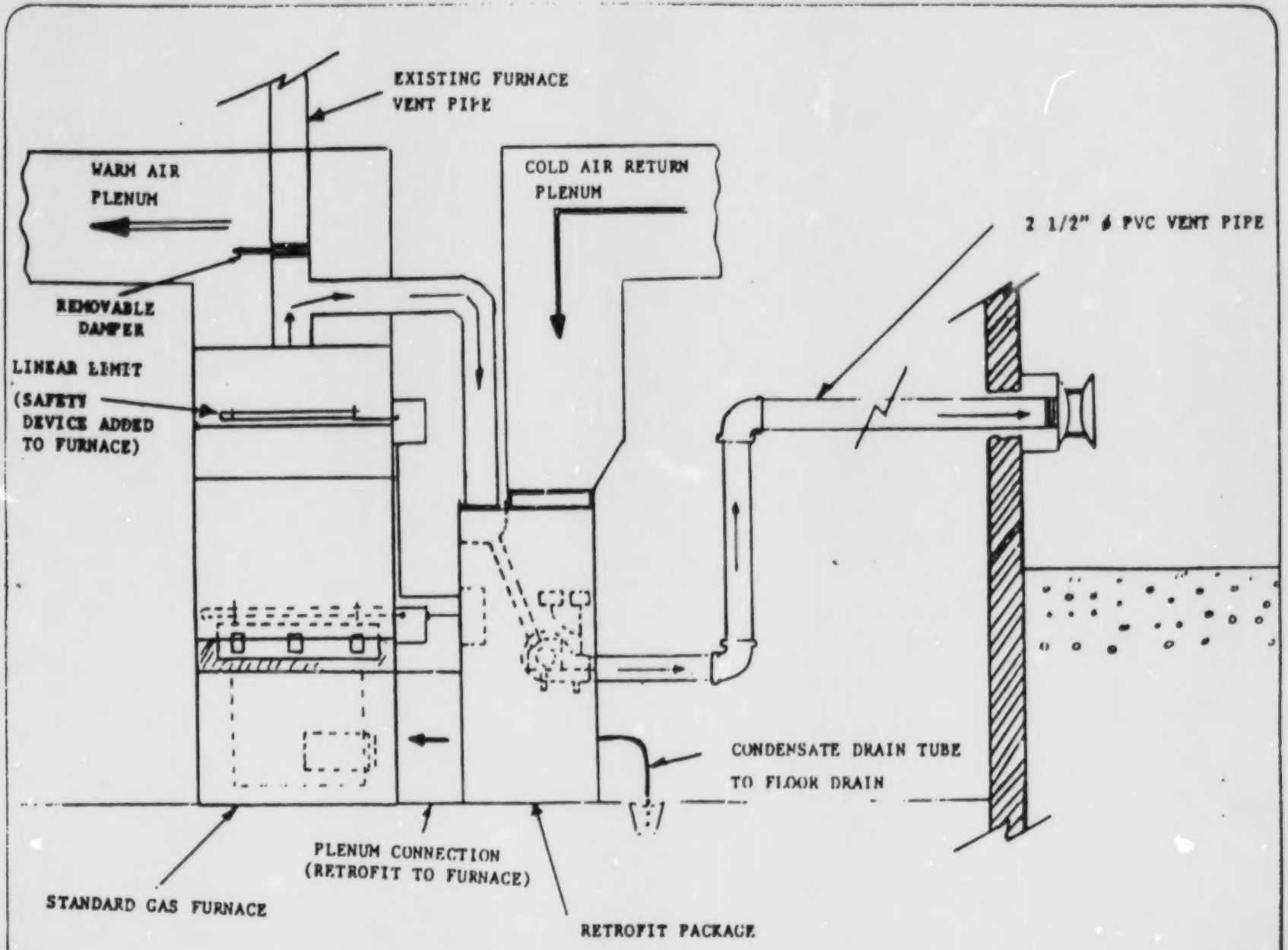
We can furthermore return the system to that of a standard vented furnace by the removal of a flue damper and the flick of a switch.

We request that C.G.A. examine and test this appliance under existing code structure. We feel confident that the Laboratory Personnel will agree with our position.

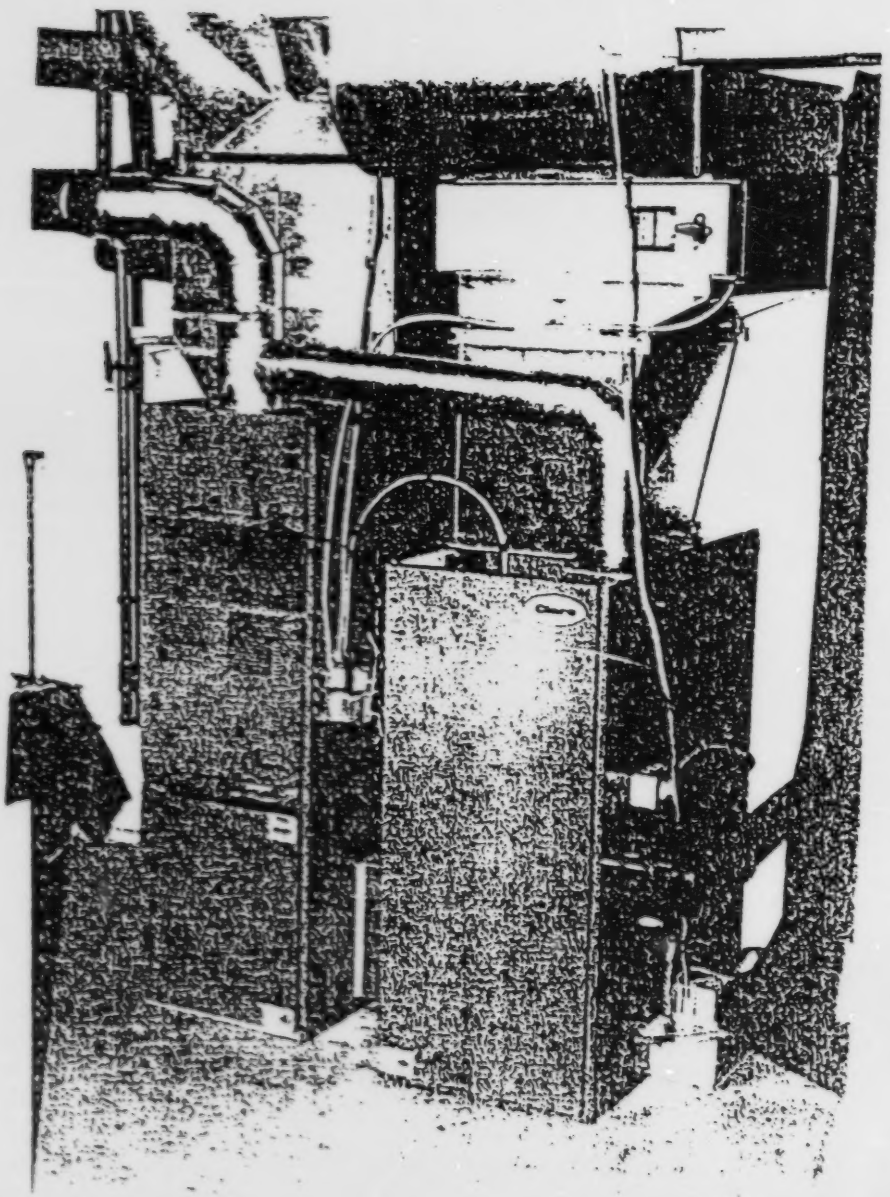
The technology is a natural extension of condensing furnace technology for manufacture of high efficiency equipment. Clare Brothers were pioneers in this technology and were in fact the first company to commercialize units in this category.

We have several years of experience and several thousand condensing furnace installations.

We feel that serious delays in obtaining an approval could very well affect our present leadership position. We request that the I.G.A.G. make it possible to begin marketing the Clare Megasave Converter in 1983-84 season.



SCHEMATIC OF HIGH EFFICIE GAS FURNACE RETROFIT PACKAGE



Clare

223 King Street, Cambridge, Ontario N3H 4T5

June 20, 1983

Canadian Gas Association,
55 Scarsdale Road,
Don Mills, Ontario. M3B 2R3

Attention: Mr. J. E. Heeley, Manager,
C.G.A. Certification Laboratory

Dear Ernie,

As we discussed at our meeting last Thursday, we would like the C.G.A. Testing Lab to proceed with a technical evaluation of our HEGR Series High Efficiency Converters. We understand that the test lab cannot proceed with testing for certification at this time.

The technical evaluation should cover four areas of concern:

(A) The original furnace, regardless of manufacture, will not be changed in any way that violates the original C.G.A. approval.

To accomplish this, we have provided a separate control system for the High Efficiency Converter so none of the furnace controls are altered. As shown in the wiring diagram provided with the detailed information package which is included with our original request for certification, all control is accomplished by breaking into the thermostat lead to the furnace. The converter is placed in the cold air return to the furnace and the vent is re-directed to the converter where flue products are power vented.

We intend to supply a redundant spillage switch to be installed on the draft hood of the original furnace. This is recommended to bring the safety of all manufacturers standard furnaces closer to the safety level of present day Clare high efficiency furnaces.

. . ./2

Clare

(B) The combustion process of the original furnace is not affected and the venting system is capable of completely clearing the furnace without draft hood spillage.

We will set up the next unit this week for testing at the maximum rated input. The randum standard furnace chosen for testing is our three section LSG Series. This unit uses the Thermodynamic Products Ltd. heat exchanger and is thus representative of several manufacturer's furnaces. This combination of furnace and High Efficiency Converter should also be evaluated for overall percentage flue loss per 2.14(g) of Can 1-2.3 as proposed for amendment June 2, 1983.

(C) The average heating contractor can be trained to install the HEGR unit with any manufacturer's furnace in a safe and professional manner. Information must be available to the utilities so that they can monitor installations.

We will provide an installation manual for assessment. This cannot be finalized until other testing is complete.

(D) The High Efficiency Converter must operate safely.

Safety evaluation should cover electrical equipment and controls, construction, venting, and applicable performance tests.

We will detail specific standards and clauses in follow up correspondence. Attached is a sheet showing sequence of operation.

Should you require any further details, please do not hesitate to contact me at (519) 653-6245.

Yours sincerely,

CLARE BROTHERS

JK/rds
Encl.

Jim Kovacs, P. Eng.,
Manager of Engineering.

Clare

HEGR SERIES HIGH EFFICIENCY CONVERTER

SEQUENCE OF OPERATION

1. Thermostat calls for heat, 24 vac is supplied to heater element of time delay relay sequencer.

2. After 1 - 20 second delay, first contacts in sequencer close and ventor fan starts. Low pressure (fan proving) switch contacts close.

3. After a 15-30 second pre-purge time, the 2nd set of contacts of sequencer close. Provided that the pressure in vent remains below the setting of the high pressure control, and the linear limit rollout switch does not sense overtemperature, the circuit is completed.

4. This completed circuit is accepted by the furnace as a call for heat and all normal furnace operations take place.

5. When the thermostat is satisfied, power to heater element of sequencer is interrupted.

6. After preset delay, 2nd contacts of sequencer open which initiates normal furnace shut down operations.

7. After 2nd delay (post purge time), 1st contacts of sequencer open and power to ventor fan is interrupted.

NOTES:

1. Furnace is shut down immediately if abnormal conditions are sensed by HEGR Controls (either pressure switches or linear limit).

2. All furnace safety controls remain in place and operational. There is no feedback to the HEGR unit. For example, ventor motor would continue to operate regardless of furnace malfunction causing shut-down.

June 22, 1983

Canadian Gas Association

Association Canadienne du Gaz

June 29, 1983

TO: MEMBERS OF THE INTERPROVINCIAL GAS ADVISORY COUNCIL AND CERTIFICATION ORGANIZATION REPRESENTATIVES

RE: MINUTES OF THE MAY 16 AND 18, 1983 IGAC MEETING

Gentlemen:

Enclosed please find a copy of the Minutes of the May 16, 18, 1983 Meeting of the Interprovincial Gas Advisory Council.

Please note that these Minutes are circulated only to the members and alternates and the certification organization representatives. A summary of the Minutes is in preparation and when published can be given a broad circulation.

Yours very truly,
CANADIAN GAS ASSOCIATION

K. Bales
Secretary
IGAC

KB/lb
TU36K

Encl.

55 Scarsdale Road, Don Mills, Ontario M3B 2R3 • (416) 447-6465 Tlx 06 966824

Canadian Gas Association / Association Canadienne du Gaz

June 29, 1983

TO: MEMBERS OF THE INTERPROVINCIAL GAS ADVISORY COUNCIL AND CERTIFICATION ORGANIZATION REPRESENTATIVES

RE: MINUTES OF THE MAY 16 AND 18, 1983 IGAC MEETING

(e) **Clare Condensing Heat Exchangers for Retrofit Application**

It was pointed out that the combination of the Clare condensing heat exchanger package when retrofitted onto a conventional atmospheric furnace was basically the same as the Clare Megasave Furnace except that:

(i) the draft hood remains on the retrofitted furnace
(ii) a spillage switch is installed around draft hood relief opening
(iii) conventional vent from atmospheric furnace remains but is provided with a removable damper.

A member explained that he believed the installation of this device represented a major retrofit and suggested that if any consideration was given, it should be to limit its installation to a specific furnace (Clare).

The question arose as to what effect this retrofit installation would have on the certification of the original equipment. Some members felt that any retrofit application of any device would void certification, others believed that provided the original equipment was not modified, certification would not be void. The IGAC generally agreed that there was no question that the installation of the Thermostak onto a boiler would void the certification of the boiler because of the modifications (relocation) of the draft hood.

It was moved and duly seconded that CGA be asked to undertake a report reviewing this Clare unit and its effect on the certification of the original retrofitted furnace.

- carried -

75

55 Scarsdale Road, Don Mills, Ontario M3B 2R3 • (416) 447-6465 Tlx. 06-966824

Canadian Gas Association

Association Canadienne du Gaz

August 9, 1983
File: STP #243

Clare Brothers Ltd.,
223 King Street,
Cambridge, Ontario.
N3H 4T5.

Attention: Mr. Jim Kovacs, P. Eng. Manager of Engineering

Subject: Megasave 1 add-on kit for warm air furnaces

Dear Sir:

Please, find enclosed our test report concerning the effect of addition of Megasave 1 kit on the LBG 125 furnace.

Since you did not specify any particular tests and since there are no standards for this type of equipment we carried out tests which in our opinion would be most likely affected by the addition of the Megasave 1 kit.

Please, let us know in case you require any additional tests.

Yours very truly,

CANADIAN GAS ASSOCIATION

J. Toms, P. Eng.,
Laboratory Engineer,
C.G.A. Certification Laboratory.

JT/jn

55 Scarsdale Road, Don Mills, Ontario M3B 2R3 • (416) 447-6465 Tlx. 06-966824

Laboratory Test Report

August 9, 1983

Special Testing Project #243

Effect of Add on Heatexchanger
on Forced Air Furnace.

Tests by

CANADIAN GAS ASSOCIATION
55 Scarsdale Road,
Don Mills, Ontario.
M3B 2R3

For Clare Brothers Ltd.,

1. Object

To check the effect of the addition of additional heatexchanger and power venting system on a forced air central heating furnace.

2. Equipment Tested

The tests were conducted using Clare LBG125 forced air furnace and Megasave 1 add on heatexchanger, power venter and spillage switch kit.

3. Assembly

Provided there is adequate space available the installation of the Megasave 1 Kit should not present any difficulties. Since the installation instructions were not available they could not be evaluated. The spillage switch is very exposed and some shielding for the switch and its wiring may be advisable.

4. Test Results

All tests were based on normal input of 125,000 Btuh.

Combustion

The furnace was found to comply with the combustion requirements. When operated with the Megasave 1 kit installed and equipped with minimum vent the CO_2 concentration at normal input at the flue outlet of the furnace dropped from approximately 7% to 6%.

Con't....2

Temperature Rise

The normal air temperature rise for the LBG125 furnace was set at 87°F using 6 inch blower pulley with 3¼ motor pulley 2 turns open.

Addition of the Megasave 1 kit caused the temperature rise to increase to 119°F. In order to reduce the temperature rise to normal 85°F it was necessary to change the motor pulley to 3½ inch diameter fully closed.

Motor Winding Temperature

Addition of the Megasave 1 kit to the furnace caused the motor winding temperature to increase from 167°F to 204°F.

Burner and Pilot Operation

The addition of the Megasave 1 kit had no noticable effect on the burner operation nor on the ignition characteristics of the furnace.

Flue Loss

The flue loss at the outlet of the Megasave 1 kit was approximately 13 percent. The nominal flue loss of the LBG125 furnace is 24 percent.

Venting

There is no flue gas spillage from the relief opening of the drafthood under normal operating conditions. In case the power vent is not operating the spillage switch shuts off the furnace in approximately one minute. Partial blockage of the power vent outlet causes spillage of flue gases from the relief opening of the draft hood. There is considerable spillage at the point where pressure switch of the power vent system causes frunace to shut off. Smaller restrictions cause progressively less spillage. It is possible to have some continuous spillage without any of the controls causing shutoff of the furnace.

The above features were considered the most likely affected by the addition of the Megasave 1 kit and no additional tests were conducted.

Report by:

J. Toms, P. Eng.,
Laboratory Engineer,
C.G.A. Certification Laboratory.

clare

223 King Street, Cambridge, Ontario N3H 4T5

August 17, 1983

Canadian Gas Association,
55 Scarsdale Road,
Don Mills, Ontario. M3B 2R3

Attention: Mr. J. E. Heeley

Dear Sir,

Enclosed is an official "Application for Test" form for our Model HEG-R retrofit heat reclaimer section.

Now that some preliminary test work has been done by C.G.A. on this type of unit, we are applying for official C.G.A. Certification.

The only difference in this model from the test model is that we will be using 17 tubes in the tertiary heat exchanger instead of 15 tubes. (drawing enclosed).

Yours truly,

CLARE BROTHERS

WMC/rds
Encl.

W. McCue, C.E.T.,
Engineering Division.

APPLICATION FOR TEST

CANADIAN GAS ASSOCIATION LABORATORY

5151 Cradle Road, Don Mills, Ontario M3B 2R3

Please use one set of Applications for each type and/or series of appliances. One completed form should be returned to this office along with sufficient information to determine the actual test models.

Submitter: CLARE BROTHERS

Office and Mailing Address: 223 KING ST. CAMBRIDGE, ONT N3H 4T5

Correspondence directed to: W. McCUE, C.E.T.

Invoices directed to: J. KOVACS P.ENG.

Factory (Name and Address):

Listee (Name and Address):

Type of Appliance: HEAT RECLAIMER SECTION

All models Requiring Listing	Type of Gas	0 – 2000 Feet Input Max.	0 – 2000 Feet Input Min.	0 – 2000 Feet Output	2000 – 4500 Feet Input Max.	2000 – 4500 Feet Input Min.	2000 – 4500 Feet Output
HEG-R	NAT. OR PROP.	125 000 BTUH	60 000 BTUH				

PLEASE USE ADDITIONAL SHEET FOR SECOND FACTORY LOCATION, LISTEE OR EXTRA MODEL NUMBERS

MINIMUM CLEARANCES TO COMBUSTIBLES:

Top 0 Back 0 Left Side 0 Right Side 0 Front SERVICE 18"

TYPE OF FLOOR: Combustible ☒ Non-Combustible ☐ Special Base Required Yes ☐ No ☒

TYPE OF INSTALLATION: Alcove ☐ Closet ☐

TRADE NAME(S):

DISTRIBUTOR'S LISTING REQUIRED YES ☐ NO ☐ FORWARD PARTICULARS PLEASE

CHOICE OF LABORATORY LOCATION: CGA Domestic ☒ CGA Research ☐

SIGNATURE OF APPLICANT

W. McCUE C.E.T.
Official's Name Printed

APPENDIX (e)

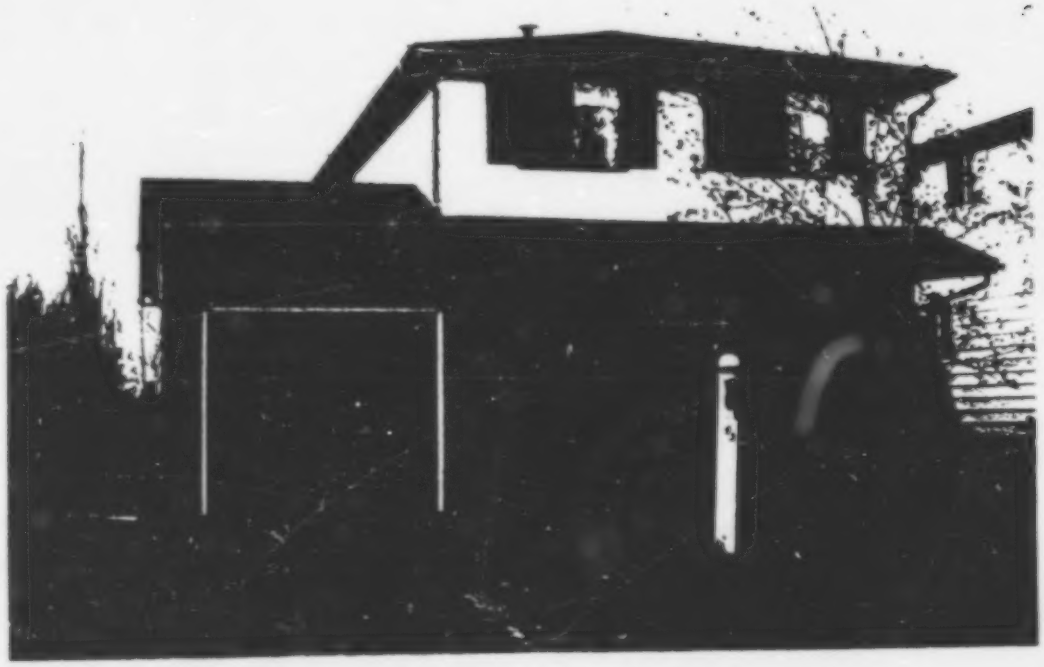
INDIVIDUAL FIELD TEST INSTALLATIONS

2.2 INDIVIDUAL INSTALLATIONS

SITE NO. 1

LOCATION: 43 Forest Glen Cr.,
Kitchener, Ontario.

OWNER: Mr. Brian Bailey



ORIGINAL SYSTEM:

The house was originally heated by a Findlay furnace, Model 2H100F9, with rated input of 100,000 BTU/hr. The furnace was 12 years old.

This furnace was replaced with a Clare HBG 60, with a rated input of 60,000 BTU/hr. and equipped with spark ignition.

DATE OF RETROFIT INSTALLATION:

November 22, 1982

SITE NO. 1

DISCUSSION OF RETROFIT:

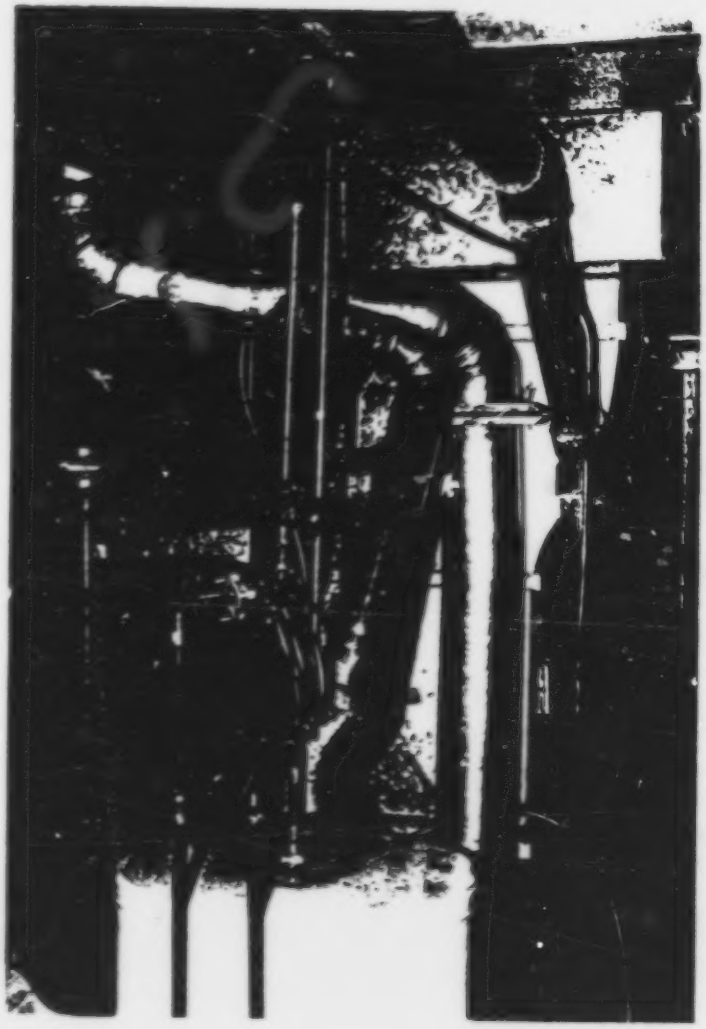
The HBG 60 furnace was retrofitted with a Model HEG-R-80 retrofit. The installation is drained by means of a condensate pump.

The 2½ inch PVC venting goes vertically upwards from the side of the retrofit, turns 90 degrees by means of two 45 degree elbows, to run horizontally away from the front of the retrofit. It then turns 90 degrees to the side of the house, to a standard riser box and terminal. Total venting requirements are 20 feet of pipe, four 90 degree elbows, and two 45 degree elbows.

SITE NO. 1 - FURNACE AND RETROFIT ARRANGEMENT

SITE NO. 1

PVC VENT PIPE AND FLUE GAS PIPE WITH DAMPER AND WATER HEATER PIPE CONNECTION



SITE NO. 1

OPERATING CHARACTERISTS:

	RETROFIT AND FURNACE
Ambient Air Temp	63°F
Flue Gas Temp at Draft Hood Outlet (with dilution air)	340°F
Flue Gas Temp at Retrofit Outlet	135°F
Air Temp. Rise Across Retrofit Coil	9°F
Air Temp. Rise Through Furnace	54°F
Total Air Temp. Rise	63°F
Carbon Dioxide in Flue Gas (With Dilution Air)	2.7%
Efficiency (Steady State)	87.5%

FUEL USEAGE COMPARISON:

Total gas use was compared for a full year before and after the installation of the retrofit.

From July 7, 1981 to July 8, 1982:

Gas Consumption: 82,800 C.F.
Degree Days (°F) 8242

Average gas use over a full year before installation of the retrofit was 10.1 cubic feet per degree day.

From April 6, 1983 to April 9, 1984:

Gas Consumption: 64,279 C.F.
Degree Days (°F): 8124

Average gas consumption for the past year, since installation of the retrofit is 7.9 cubic feet per degree day.

Total gas use has dropped 22 percent in the past year, compared to the year before installation of the retrofit. This does not account for gas used for the water heater.

SITE NO. 1

FUEL USEAGE COMPARISON...cont'd

To compensate for the hot water heater, a factor of 2000 cubic feet of gas per month is subtracted from the total gas values.

From July 7, 1981 to July 8, 1982:

Gas consumption for heating - 58 800 C.F.
Average heating gas use - 7.1 C.F./D.D.

From April 6, 1983 to April 9, 1984:

Gas consumption for heating - 40 279 C.F.
Average heating gas use - 5.0 C.F./D.D.

Gas consumption for heating has dropped by 29.6 percent since the retrofit was installed.

SITE NO. 2

LOCATION: 122 Edward St.,
Cambridge, Ontario.

OWNER: Mr. Derek Spencer

ORIGINAL SYSTEM:

The original heating system was a low boy Clawsey-Sohrt furnace with an approximate input of 100,000 BTU/hr. It was 14 years old.

The furnace was replaced with a Clare MBG 60 with rated input of 60,000 BTU/hr. It is equipped with spark ignition. The installation has an electronic air cleaner and 1½ tons of central air conditioning.

Natural gas is also used for the clothes dryer and water heater.

DATE OF RETROFIT INSTALLATION:

December 16, 1982

SITE NO. 2

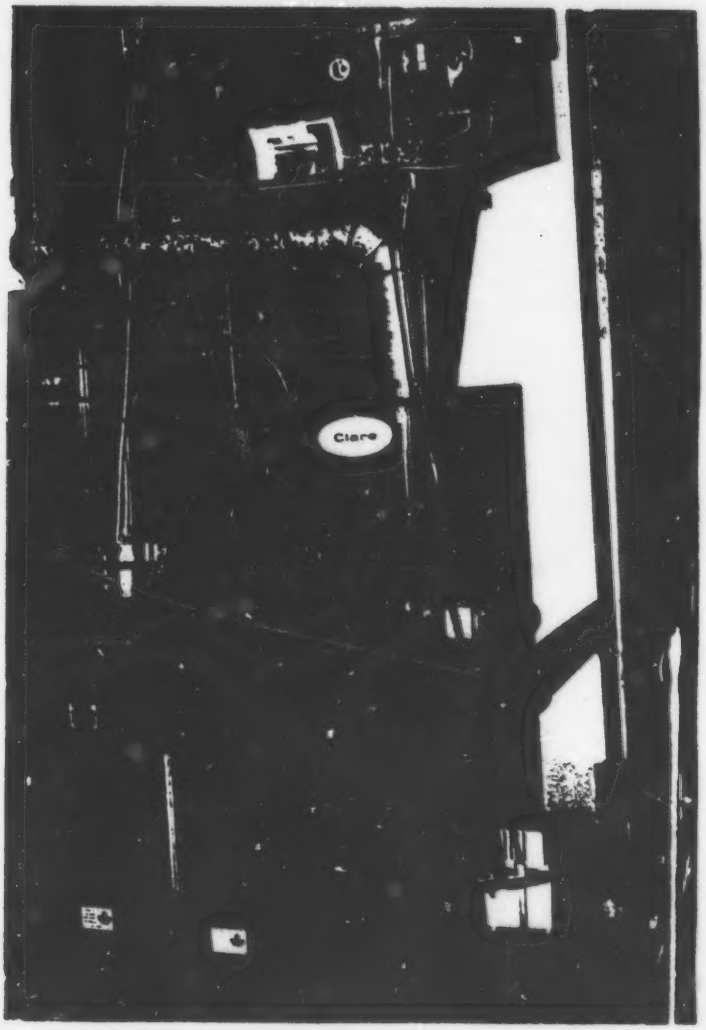
DISCUSSION OF RETROFIT:

An HEG-R-80 Retrofit was installed with the MBG 60 furnace. A condensate pump is used to drain the water from the retrofit to a laundry sink. The electronic air cleaner is located in the return air duct above the retrofit. The evaporator coil of the central air conditioning system is in the warm air supply duct above the furnace. Its location is not affected by the retrofit.

The 2½ inch PVC venting turns from the side of the retrofit and runs straight back through the wall behind the retrofit into the garage. It turns and rises along the wall at 45 degrees then runs horizontally through the back wall of the garage to the standard riser box and vent terminal. This venting arrangement requries 20 linear feet of pipe, four 90 degree elbows and one 45 degree elbow.

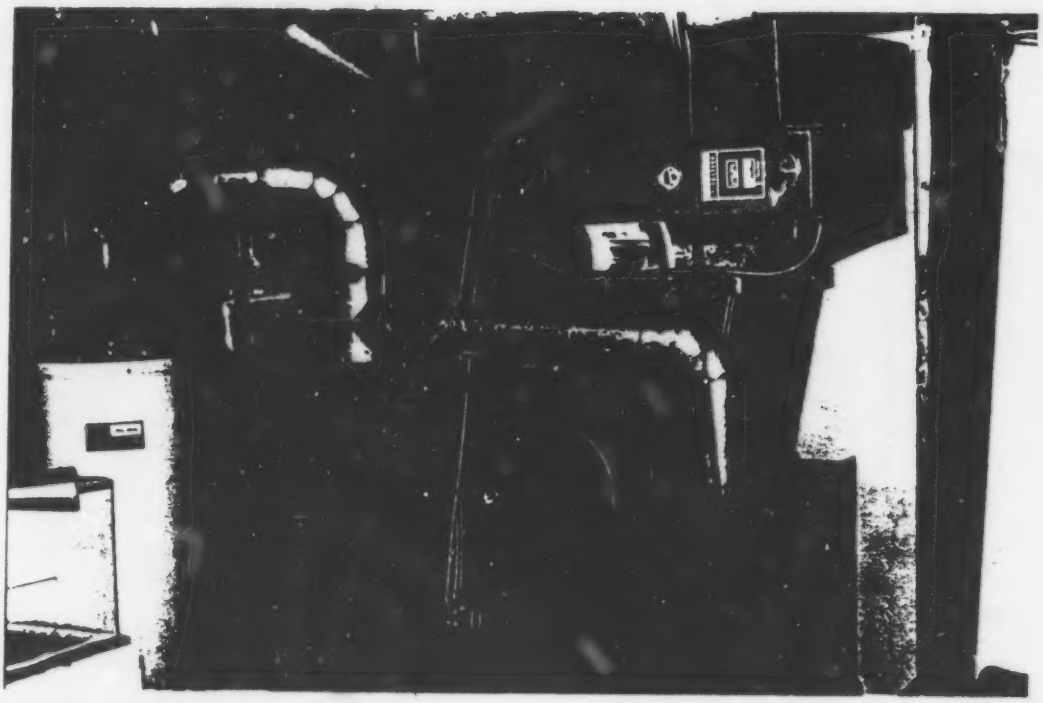
SITE NO. 2

INSTALLATION SHOWING AIR CLEANER, VENTING AND CONDENSATE PUMP.



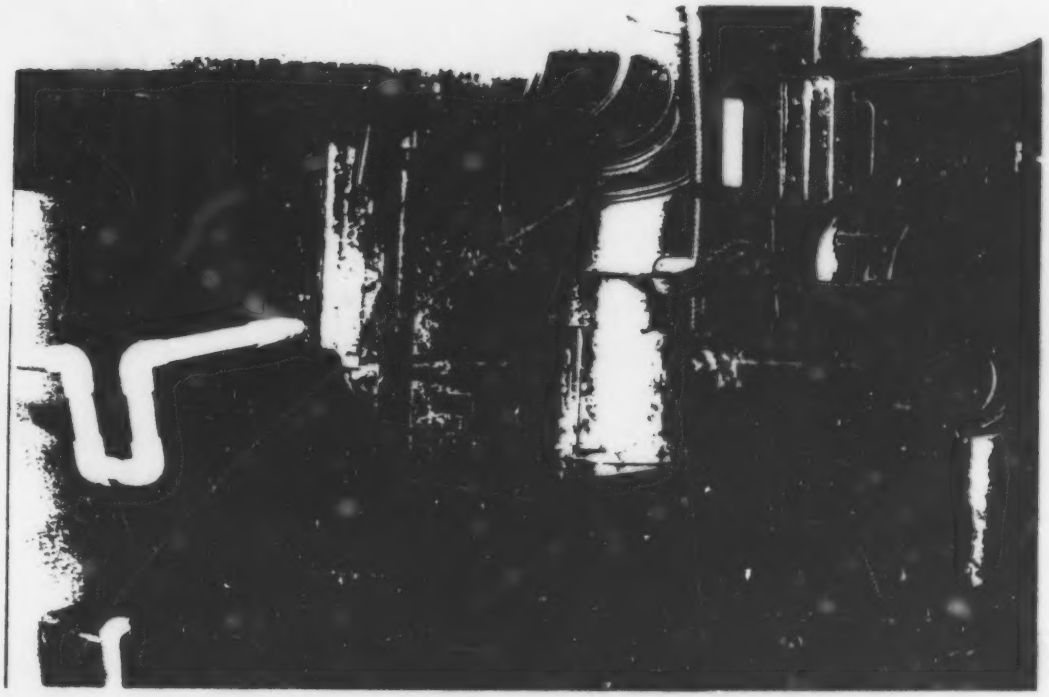
SITE NO. 2

ARRANGEMENT OF FLUE GAS CONNECTION BETWEEN FURNACE AND RETROFIT WITH DAMPER.



SITE NO. 2

FLUE GAS CONNECTION WITH DAMPER AND AIR CONDITIONING EVAPORATOR COIL CONNECTIONS AND DRAIN IN SUPPLY AIR DUCT.



SITE NO. 2

OPERATING CHARACTERISTICS:

	FURNACE	FURNACE-RETROFIT
Ambient Air Temp	71°F	70°F
Flue Gas Temp. at Draft Hood Outlet (with dilution air)	365°F	470°F
Flue Gas Temp. at Retrofit Outlet	-	131°F
Air Temp. Rise Across Retrofit Coil	-	14°F
Air Temp. Rise Through Furnace	82°F	75°F
Total Air Temp. Rise	82°F	89°F
Carbon Dioxide in Flue Gas (with Dilution Air)	2.7%	3.8%
Efficiency (Steady State)	73.0%	86.5%

FUEL USEAGE COMPARISON:

An analysis of natural gas useage for the 1983-84 heating season was carried out. The separate gas meter was used to isolate the amount of gas used specifically for heating, and from this, the amount of gas used for the clothes dryer and water heater. A comparison with the degree days for the region gives an average amount of gas required for heating for each degree day.

A comparison was done for the 1981-82 heating season assuming the same dryer and water heater gas consumption as was found for 1983-84, to determine the savings.

For 1983-1984 heating season: (October to March)

Total Gas:	69,000 C.F.	
Heating GAs	44,400 C.F.	
Dryer and Water Heater	24,600 C.F.	∴ (4100 C.F./Month)

Degree Days (°F) 6711

An average of 6.6 cubic feet of gas is required for heat for each degree day since the retrofit was installed.

SITE NO. 2

FUEL USEAGE COMPARISON...cont'd

For 1981-82 heating season (Mid Sept. to Mid Apr.):

Total Gas Consumption:	96,088 C.F.
Dryer & Water Heater Gas:	28,700 C.F.
Heating Gas	67,388 C.F.

Degree Days (^{o}F) 7502

An average of 9.0 cubic feet of gas was required for heat for each degree day before the retrofit was installed.

A comparison of the values shows that the gas consumption for heating decreased by 27% since the installation of the retrofit.

SITE NO. 3

LOCATION: 1260 Fairview Road,
Cambridge, Ontario.

OWNER: Mr. E. da Silva

ORIGINAL SYSTEM:

The The heating system was a Clare HBG 138 furnace with an input of 125,000 BTU/hr. It was equipped with a Clare humidifier between the return air duct and the supply air duct, and had spark ignition. It was 3 years old.

A gas hot water heater is also used.

DATE OF RETROFIT INSTALLATION:

December 17, 1982

SITE NO. 3

DISCUSSION OF RETROFIT:

An HEG-R-120 Retrofit was installed with the original furnace. The input was adjusted to approximately 120,000 BTU/hr. The condensate is removed from the retrofit to a drain by gravity. The Clare humidifier is still located between the return air and supply air ducts.

A 1½ ton central air conditioning unit was added since the retrofit installation.

The 2½ inch PVC venting rises from the side of the retrofit, turns 45 degrees and rises to the basement ceiling where it turns 45 degrees to run along the ceiling above the furnace retrofit. After another 90 degree elbow, the vent goes through the wall at the side of the house to a riser box and vent terminal. Fifteen feet of pipe, four 90 degree elbows and two 45 degree elbows are required.

SITE NO. 3

DISCUSSION OF RETROFIT:

An HEG-R-120 Retrofit was installed with the original furnace. The input was adjusted to approximately 120,000 BTU/hr. The condensate is removed from the retrofit to a drain by gravity. The Clare humidifier is still located between the return air and supply air ducts.

A 1½ ton central air conditioning unit was added since the retrofit installation.

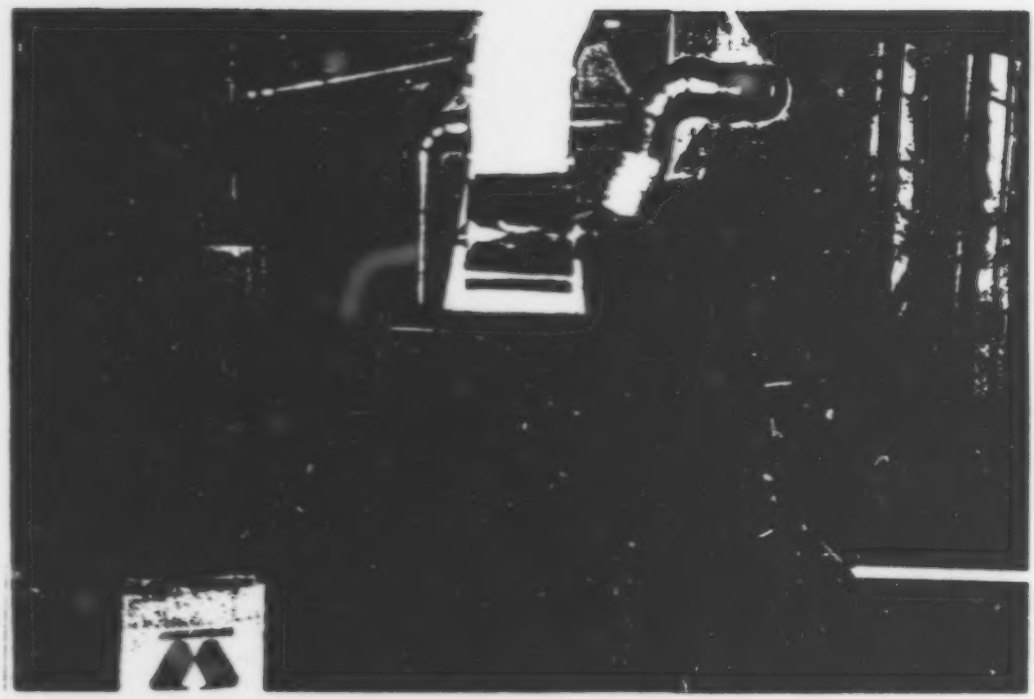
The 2½ inch PVC venting rises from the side of the retrofit, turns 45 degrees and rises to the basement ceiling where it turns 45 degrees to run along the ceiling above the furnace retrofit. After another 90 degree elbow, the vent goes through the wall at the side of the house to a riser box and vent terminal. Fifteen feet of pipe, four 90 degree elbows and two 45 degree elbows are required.

SITE NO. 3

HUMIDIFIER INSTALLATION AND DUCTING

SITE NO. 3

FURNACE INSTALLATION WITH GAS WATER HEATER



SITE NO. 3

OPERATING CHARACTERISTICS:

	FURNACE ONLY	FURNACE & RETROFIT
Ambient Air Temp	69°F	69°F
Flue Gas Temp. at Draft Hood Outlet (with dilution air)	330°F	510°F
Flue Gas Temp. at Retrofit Outlet	-	124°F
Air Temp. Rise Across Retrofit Coil	0°F	16°F
Air Temp. Rise Through Furnace	120°F	130°F
Total Air Temp. Rise	120°F	146°F
Carbon Dioxide in Flue Gas (with dilution air)	2.7%	4.2%
Efficiency (Steady State)	73.0%	87.8%

GAS USEAGE COMPARISON:

Total gas consumption is compared for total heating seasons from before and after the retrofit was installed with the furnace.

From September 25, 1981 to May 26, 1982:

Gas Consumption: 133,790 C.F.
Degree Days (°F) 7853

Average gas use over this time period was 17.0 cubic feet per degree day.

From September 26, 1983 to April 25, 1984

Gas Consumption: 92,099 C.F.
Degree Days (°F) 7319

The average gas consumption for the most recent heating season is 12.6 cubic feet per degree day.

The total gas consumption has decreased by 26 percent since the retrofit was installed.

SITE NO. 3

GAS USEAGE COMPARISON...con't

A factor of 2 MCF per month included to compensate for the water heater, gives a more realistic value for actual heating savings.

From September 25, 1981 to May 26, 1982:

Gas Consumption for heating - 117 790 C.F.
Average Heating Gas Use - 15.0 C.F./D.D.

From September 26, 1983 to April 25, 1984:

Gas Consumption for heating - 78 099 C.F.
Average Heating Gas Use - 10.7 C.F.

Gas consumption for heating has decreased by 28.7 percent.

SITE NO. 4

LOCATION: 3 McCammon St.
Paris, Ontario.

OWNER: Mr. Paul Perreault

ORIGINAL SYSTEM:

The original furnace was a Clawsey-Sohrt 90 GLB which was approximately 13 years old. It was fixed at an input of 90,000 BTU/hour.

It was replaced by an Olsen HBS-72 E fired at an input of 75,000 BTU/hour. It is equipped with spark ignition.

A 1½ ton central air conditioning system is installed in the house.

DATE OF RETROFIT INSTALLATION:

December 20, 1982

SITE NO. 4

DISCUSSION OF RETROFIT:

The Olsen furnace was installed with a HEG-R-80 retrofit. A pump is used to drain the condensate from the retrofit to a sink. The air conditioner evaporator coil is located in the supply air duct.

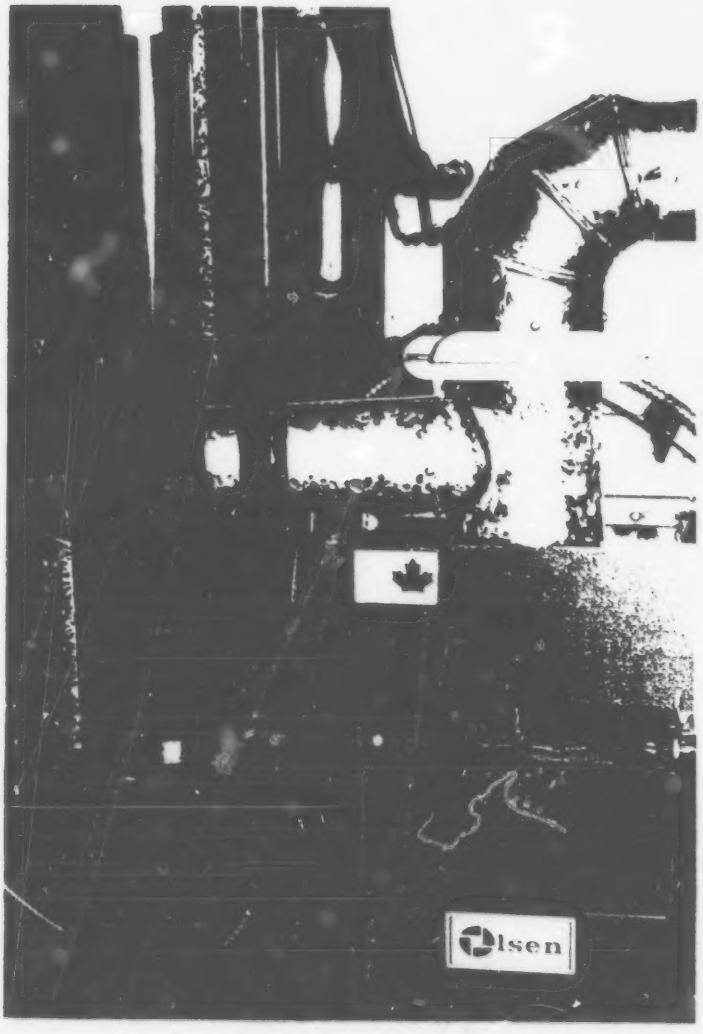
The 2½ inch PVC vent pipe rises from the side of the retrofit at an angle to clear the front of the unit and then rises to the ceiling. It runs horizontally along the ceiling at a 45 degree angle away from the front of the furnace to a 45 degree elbow and through the wall to a riser box and vent terminal.

SITE NO. 4

RETROFIT, FURNACE AND WATER HEATER ARRANGEMENT SHOWING FLUE GAS PIPING AND VENTING.

SITE NO. 4

VIEW OF FLUE PIPE CONNECTION BETWEEN FURNACE AND RETROFIT WITH REMOVABLE DAMPER, AND ADDED LINEAR LIMIT ABOVE DRAFT HOOD ON ORIGINAL FURNACE.



SITE NO. 4

OPERATING CHARACTERISTICS:

	FURNACE	FURNACE-RETROFIT
Ambient Air Temp.	63°F	63°F
Flue Gas Temp. at Draft Hood Outlet (with Dilution Air)	190°F	360°F
Flue Gas Temp. at Retrofit Outlet	-	121°F
Air Temp. Rise Across Retrofit Coil	0°F	24°F
Air Temp. Rise Through Furnace	85°F	73°F
Total Air Temp. Rise	85°F	97°F
Carbon Dioxide in Flue Gas (with Dilution Air)	1.4%	3.9%
Efficiency (Steady State)	75.0%	87.7%

FUEL USEAGE COMPARISON:

Fuel consumption for this test home were recorded for a year prior to the retrofit installation to the present. Comparisons were based on these records, degree data information and a 2 MCF/month correction to allow for water heater gas use.

From November 9, 1981 to December 10, 1982:

Gas consumption - 90,700 C.F.
Gas consumption for heating - 64,700 C.F.
Degree Days (°F) 9072

The average amount of gas used for heating over the year before the retrofit was installed is 7.2 cubic feet per degree day.

From January 12, 1983 to March 14, 1984:

Gas consumption - 91,000 C.F.
Gas consumption for heating - 63,000 C.F.
Degree Days (°F) 10,182

Average gas for heating since installation of the retrofit is

SITE NO. 4

FUEL USEAGE COMPARISON...con't

about 14 percent.

A further calculation of gas consumption for the last winter shows a further savings.

From September 14, 1983 to March 14, 1984:

Gas consumption - 488,000 C.F.
Gas consumption for heating - 36,800 C.F.
Degree Days (^{o}F) 6183

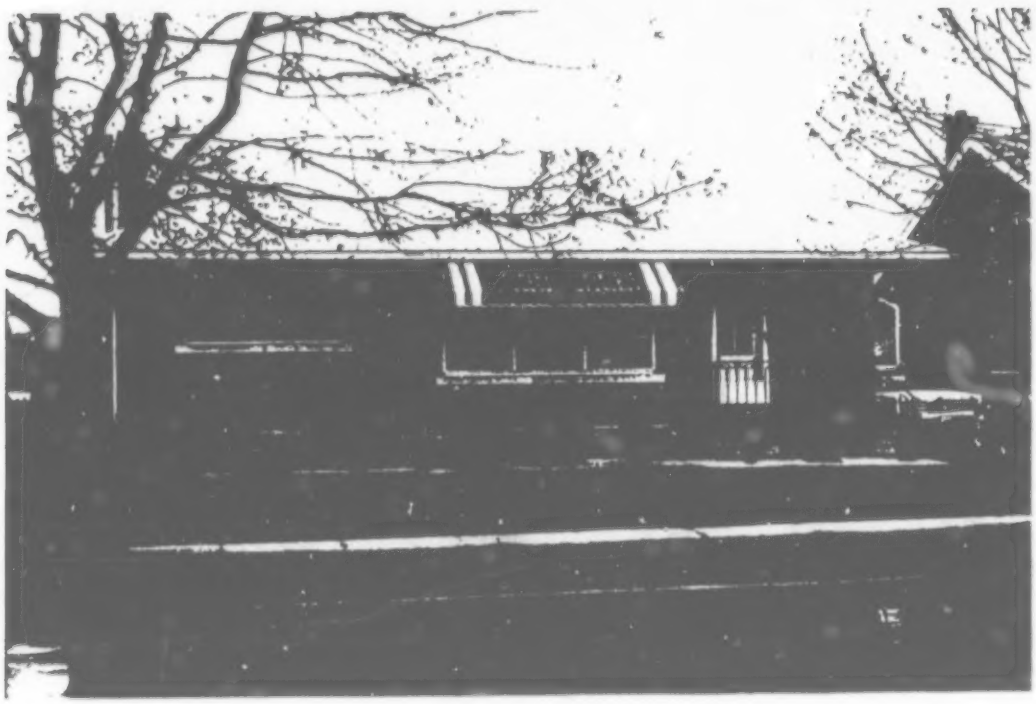
The average gas use for heating during the last winter was 5.95 cubic feet per degree day.

The savings in the last winter, compared to the year before installation is 17.3 percent.

SITE NO. 5

LOCATION: 1047 Clare Ave.
Cambridge, Ontario

OWNER: Mrs. Charlotte Hushley



ORIGINAL SYSTEM:

Heating was supplied by a Clare LBC 102 with an input of 102,000 BTU/hr. It was about one year old.

It had a humidifier on the supply air duct.

DATE OF RETROFIT INSTALLATION:

December 22, 1982

SITE NO. 5

DISCUSSION OF RETROFIT:

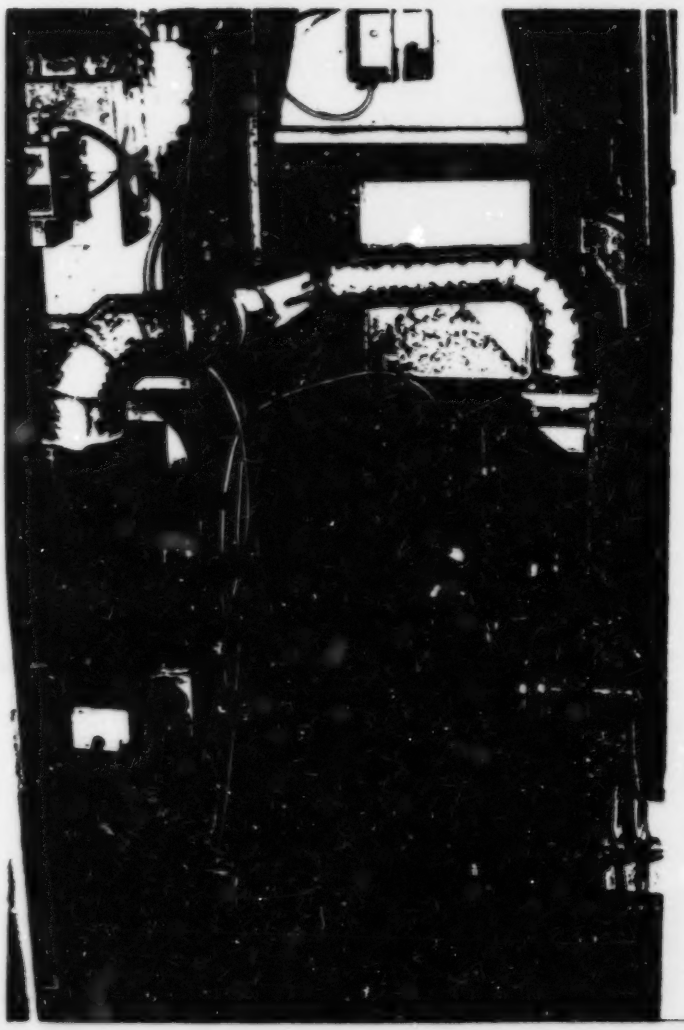
A HEG-R-120 Retrofit was installed with the furnace. The furnace input was adjusted to about 95,000 BTU/hr. A condensate pump is used to pump the water from the retrofit to the drain in an adjacent bathroom.

The humidifier is still located above the furnace on the supply air duct, although it has been turned off because it was no longer required.

The 2½ inch venting rises to the basement ceiling where it runs horizontally with 2 - 45 degree bends through the wall to a riser box and vent terminal. The vent on this installation uses 15 linear feet of pipe, 4-90 degree elbows, and 2-45 degree elbows.

SITE NO. 5

RETROFIT INSTALLED WITH LOW BOY FURNACE, SHOWING FLUE PIPE CONNECTIONS.



SITE NO. 5

OPERATING CHARACTERISTICS:

	FURNACE ONLY	FURNACE AND RETROFIT
Ambient Air Temp	70°F	70°F
Flue Gas Temp. at Draft Hood Outlet (with Dilution Air)	305°F	330°F
Flue Gas Temp. at Retrofit Outlet	-	113°F
Air Temp. Rise Across Retrofit Coil	0°F	17°F
Air.Temp. Rise Through Furnace	91°F	73°F
Total Air Temp. Rise	91°F	90°F
Carbon Dioxide in Flue Gas (with Dilution Air)	3.3%	3.8%
Efficiency (Steady State)	74.4%	87.6%

GAS USEAGE COMPARISON:

A comparison of total gas consumption has been carried out using complete heating seasons before and after the retrofit was installed.

From September 1981 to May 1982:

Gas Consumption: 74,700 C.F.
Degree Days (°F) 7909

Average gas use before installation of the retrofit was 9.4 cubic feet of gas per degree day.

From September 2, 1983 to May 3, 1984:

Gas Consumption 58,199 C.F.
Degree Days (°F) 7601

In the past heating season average gas use was 7.7 cubic feet per degree day.

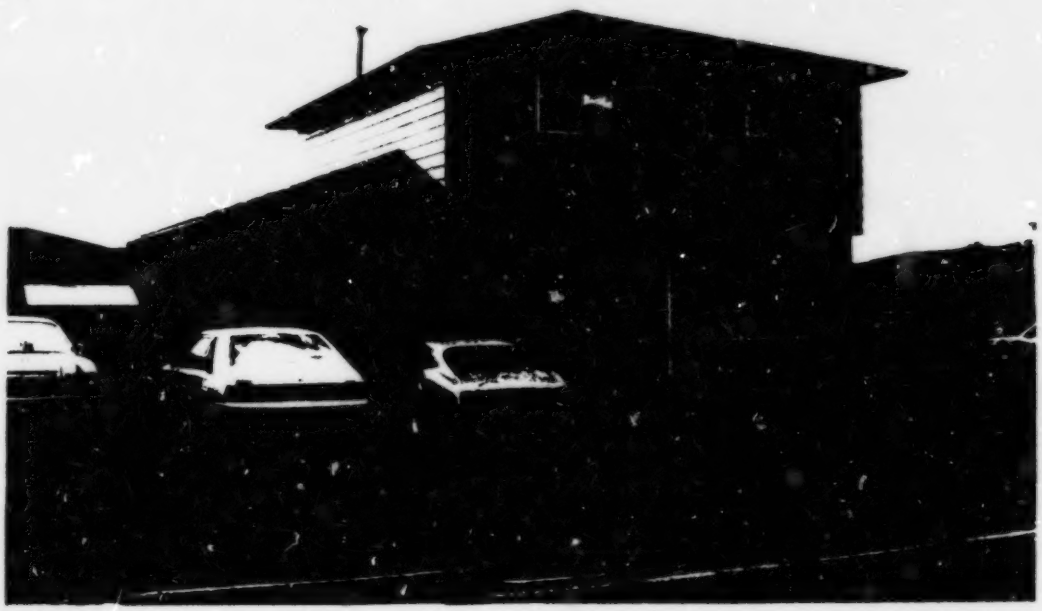
Savings in total gas used since the retrofit was installed is approximately 19 percent.

Since no other gas appliances are used in this house, gas savings calculated apply to heating only.

SITE NO. 6

LOCATION: 1156 Michael Cres.,
Cambridge, Ontario

OWNER: Mr. Manuel Cardoso



ORIGINAL SYSTEM:

The house was originally heated by a Lennox G8-110T with an input rate of 110,000 BTU/hr. The furnace was 12 years old, and had a standing pilot.

A gas hot water heater is also in use.

DATE OF RETROFIT INSTALLATION:

December 23, 1982

SITE NO. 6

DISCUSSION OF RETROFIT:

The furnace was retrofitted with a HEG-R-120 and the furnace input was reduced to approximately 95,000 BTU/hr. It still has a standing pilot.

Condensate is drained off by gravity to a drain in the floor.

A central air conditioner was added after the retrofit was installed.

The 2½ inch vent pipe rises at an angle from the side of the retrofit, to avoid the flue pipe. It runs along the front of the return and supply ducts, rises again at 45° to the ceiling and runs horizontally through the outside wall to a vent terminal. This arrangement requires 20 linear feet of pipe, 4-90 degree elbows and 4-45° elbows.

SITE NO. 6

SIDE VIEW OF INSTALLATION WITH RETROFIT AND WATER HEATER IN BACKGROUND. AIR CONDITIONING COIL CONNECTIONS IN SUPPLY DUCT.

SITE NO. 6

OPERATING CHARACTERISTICS:

	FURNACE ONLY	FURNACE & RETROFIT
Ambient Air Temp.	75°F	75°F
Flue Gas Temp. at Draft Hood Outlet (with Dilution Air)	550°F	570°F
Flue Gas Temp. at Retrofit Outlet	-	143°F
Air Temp. Rise Across Retrofit Coil	0°F	16°F
Air Temp. Rise Through Furnace	170°F	160°F
Total Air Temp. Rise	170°F	176°F
Carbon Dioxide in Flue Gas (with Dilution Air)	2.8%	3.3%
Efficiency (Steady State)	68%	87.2%

FUEL USEAGE COMPARISON:

A comparison of total gas consumption was carried out for complete heating seasons before and after the retrofit was installed.

From September 29, 1981 to May 27, 1982:

Gas Consumption: 158,998 C.F.
Degree Days (°F) 7798

Average gas use was 20.4 cubic feet of gas per degree day before the retrofit was added.

From September 23, 1983 to April 24, 1984:

Gas Consumption: 118,201 C.F.
Degree Days (°F) 7346

Since the retrofit was installed average gas use is 16.1 cubic feet per degree day.

The savings in the total gas bill is 21 percent since the retrofit was installed.

SITE NO. 6

FUEL USEAGE COMPARISON...con't

Assuming an average amount of gas required for the hot water heater of 2 MCF per month, an estimate can be made of savings in heating costs.

From September 29, 1981 to May 27, 1982:

Gas consumption for heating - 142,998 C.F.
Degree Days (^{o}F) 7798

Gas required for heating averaged 18.3 cubic feet per degree day.

From September 23, 1983 to April 24, 1984:

Gas consumption for heating - 104 201 C.F.
Degree Days (^{o}F) 7346

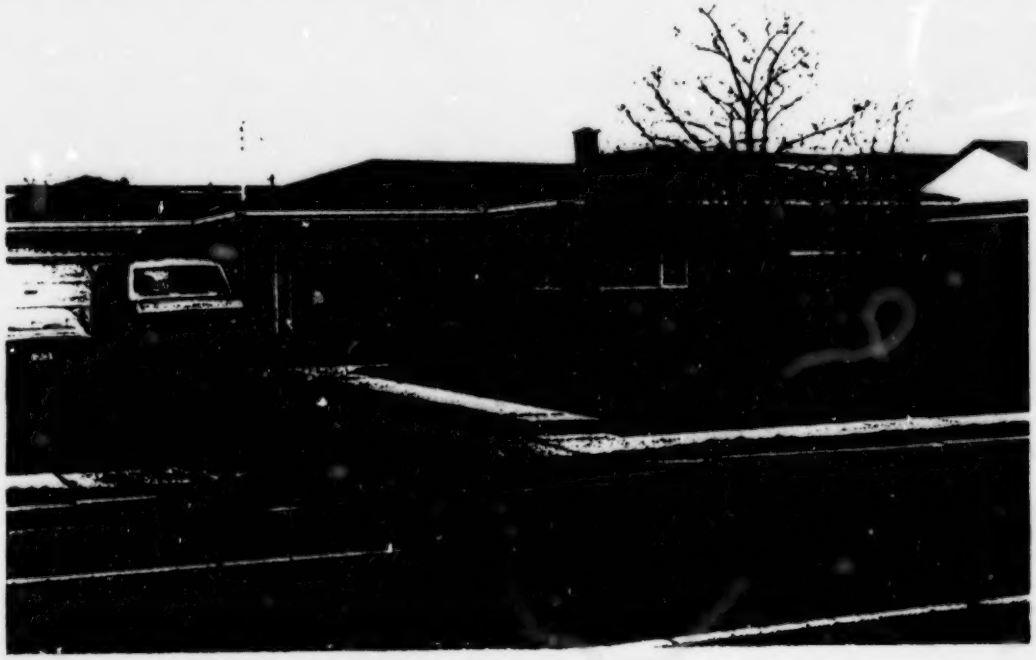
Since installation of the retrofit, average gas use for heating has been 14.2 cubic feet per degree day.

The savings in the heating gas is 22.4 percent since the retrofit was installed.

SITE NO. 7

LOCATION: 1520 Concession Road,
Cambridge, Ontario.

OWNER: Mr. Owen Coles



ORIGINAL SYSTEM:

The original furnace was a Clare G126LB furnace with 126,000 BTUH/hr. input. It was approximately 15 years old.

It was replaced for this test by a Flame Master FM70HB rated for an input of 70,000 BTU/hr. The furnace was equipped with spark ignition.

DATE OF RETROFIT INSTALLATION:

January 7, 1983

SITE NO. 7

DISCUSSION OF RETROFIT:

The Flame Master furnace was retrofitted with an HEG-R-80 Retrofit. The furnace input was adjusted to approximately 60,000 BTU/hr. input.

Drainage of the retrofit is by gravity. Spark ignition remains on the furnace. A Clare drum style humidifier is fitted on the return air duct and a 1½ ton central air conditioning evaporator coil is located in the supply air duct.

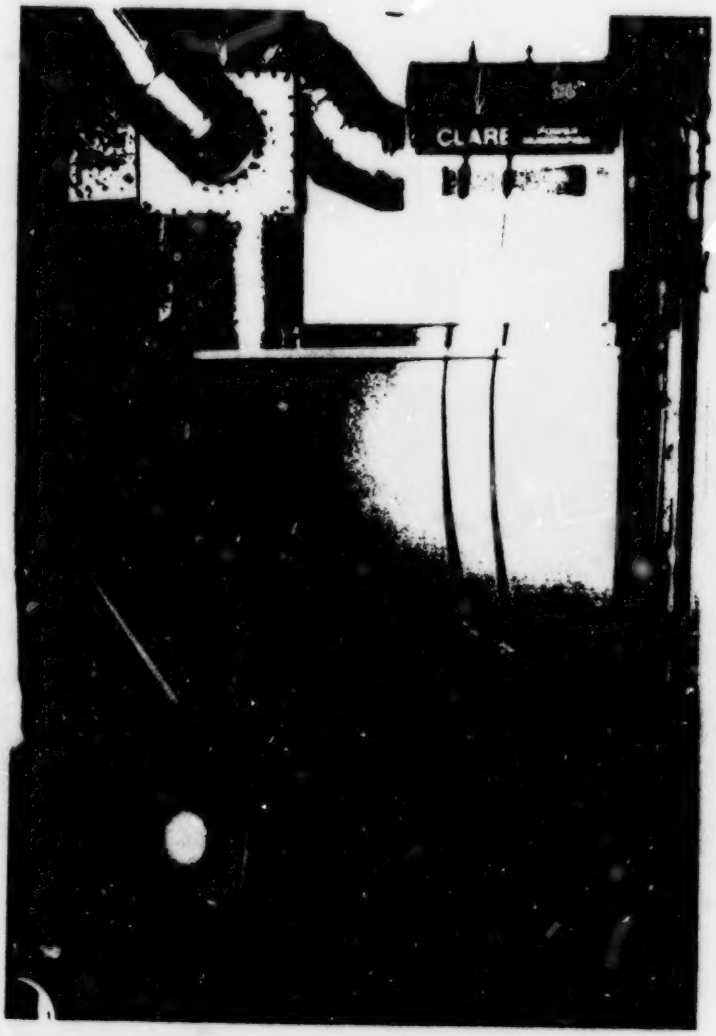
The furnace and retrofit were installed in an extremely tight space. The furnace room has only 16 inches of access room at the front of the retrofit and furnace with access doors at each end of the room. The installation was completed without disturbing the walls in any way.

The 2½ inch venting rises at an angle from the side of the retrofit to the wall of the furnace room. It goes horizontally to the front of the furnace where it rises at a 45 degree angle to a 90 degree elbow at the ceiling of the basement.

The venting goes through the wall to a riser box and vent terminal. Fifteen linear feet of pipe, five 90 degree elbows and one 45 degree elbow were required for the venting.

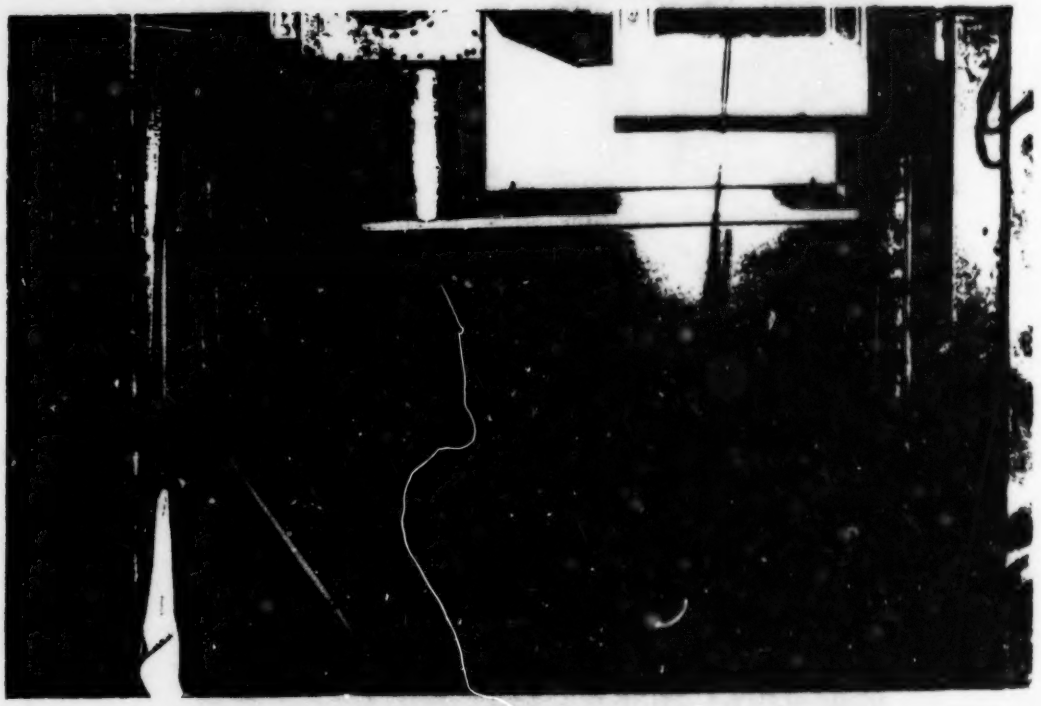
SITE NO. 7

SHOWING RETROFIT IN SMALL FURNACE ROOM



SITE NO. 7

SHOWING RETROFIT IN SMALL FURNACE ROOM



SITE NO. 7

OPERATING CHARACTERISTICS:

	FURNACE ONLY	FURNACE & RETROFIT
Ambient Air Temp.	74°F	71°F
Flue Gas Temp at Draft Hood Outlet (with dilution air)	380°F	570°F
Flue Gas Temp. at Retrofit Outlet	-	136°F
Air Temp. Rise Across Retrofit Coil	0°F	21°F
Air Temp. Rise Through Furnace	65°F	64°F
Total Air Temp. Rise	65°F	85°F
Carbon Dioxide in Flue Gas (with dilution air)	2.8%	3.3%
Efficiency (Steady State)	70%	86.3%

GAS USEAGE COMPARISON

A comparison of gas useage has been done for a complete heating season before and after the retrofit was installed.

From October 1981 to April 1982:

Gas Consumption: 83,598 C.F.
Degree Days (°F): 7587

Average gas consumption before the retrofit was installed was 11.0 cubic feet per degree day.

From September 26, 1983 to April 25, 1984:

Gas consumption: 81,795 C.F.
Degree Days (°F): 7318.8

Average gas use since the retrofit was installed is 11.2 cubic feet per degree day.

SITE NO. 7

GAS USEAGE COMPARISON...cont'd

Gas consumption has actually increased approximately 2% since the retrofit was installed. However, the increase seems to be due to unusually high gas consumption from January 1984 to March 1984, during which time a separate gas heater was used to heat a lightly insulated garage. This was not done during the 1981-82 heating season that was analyzed.

From September 26, 1983 to December 24, 1983:

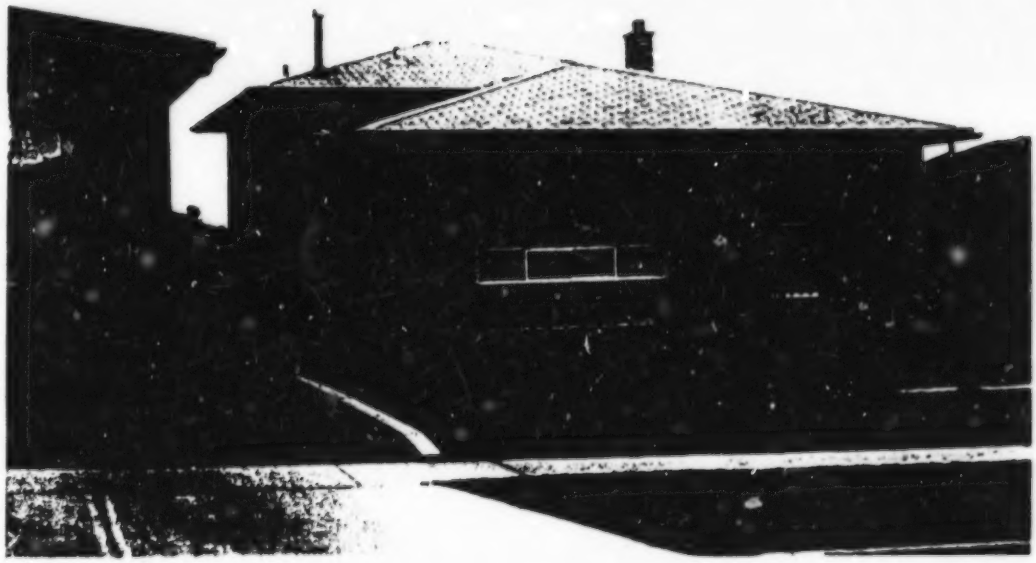
Gas Consumption:	18,698 C.F.
Degree Days (^{o}F)	2421

In this time period, average use was 7.7 cubic feet of gas per degree day, a 30 percent improvement over the earlier heating season.

SITE NO. 8

LOCATION: 139 Bakersfield Drive.
Cambridge, Ontario

OWNER: Mr. Tony Figueiredo



ORIGINAL SYSTEM:

The original heating was done by an Intercity HGD 100 furnace with an input of 100,000 BTU/hr. It was 3 years old.

It was replaced by an Olsen 105 withstanding pilot.

A gas hot water heater is also used.

DATE OF RETROFIT INSTALLATION:

January 11, 1983

SITE NO. 8

DISCUSSION OF RETROFIT:

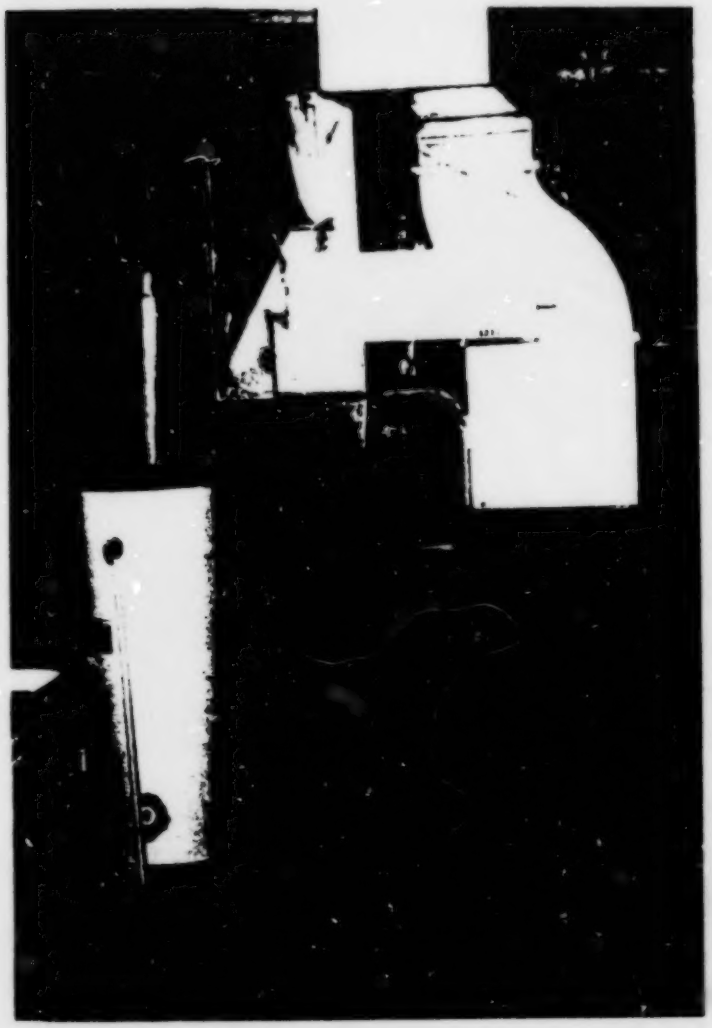
The Olsen furnace was fitted with a HEG-R-120 retrofit. The furnace input was reduced to 97,000 BTU/hr.

A gravity system is used to drain the condensate formed in the retrofit. A humidifier is attached to the supply and return air ducts.

The 2½ inch venting rises at a 45 degree angle from the side of the retrofit unit. After clearing the front of the retrofit the venting rises vertically and then turns and goes along the basement ceiling and through the wall to a riser box and vent terminal. This venting arrangement requires 10 linear feet of venting, 4-90 degree elbows and 1-45 degree elbow.

SITE NO. 8

BACK VIEW OF INSTALLATION SHOWING WATER HEATER, FURNACE AND RETROFIT.



SITE NO. 8

SIDE VIEW OF RETROFIT SHOWING FLUE CONNECTIONS, VENT PIPING AND DUCT WORK.

SITE NO. 8

OPERATING CHARACTERISTICS:

	FURNACE	FURNACE & RETROFIT
Ambient Air Temp	70°F	69°F
Flue Gas Temp. at Draft Hood outlet (with dilution air)	500°F	515°F
Flue Gas Temp. at Retrofit Outlet	-	131°F
Air Temp. Rise Across Retrofit Coil	0°F	23°F
Air Temp. Rise Through Furnace	125°F	89°F
Total Air Temp. Rise	125°F	112°F
Carbon Dioxide in Flue Gas (With Dilution Air)	3.9%	4.3%
Efficiency (Steady State)	75.0%	87.2%

COMPARISON OF FUEL USEAGE:

Gas consumption is compared in two complete heating seasons. One before installation of the retrofit and one after.

From September 23, 1981 to May 24, 1982:

Gas Consumption: 124,501 C.F.
Degree Days (°F): 7867.8

In this time period average gas consumption was 15.8 cubic feet per degree day.

From September 16, 1983 to April 16, 1984:

Gas Consumption: 93,498 C.F.
Degree Days (°F): 7225.2

In the past heating season, average gas useage has been 12.9 cubic feet per degree day.

A savings in total gas useage of 18 percent occurred since the retrofit was installed.

SITE NO. 8

COMPARISON OF FUEL USEAGE...con't

To determine savings in gas use for heating only, a factor of 2 MCF per month is applied to the total gas figures.

From September 23, 1981 to May 24, 1982:

Gas consumption for heating - 108,501 C.F.
Degree Days (^{o}F) - 7868

The average gas use for heating was 13.8 cubic feet per degree day.

From September 16, 1983 to April 16, 1984:

Gas consumption for heating - 79 498 C.F.
Degree Days (^{o}F) - 7225

During this time period the average amount of gas required for heating was 11.0 cubic feet per degree day.

The savings in heating gas was about 20 percent since the retrofit unit was installed.

SITE NO. 9

LOCATION: 535 Church Street,
Cambridge, Ontario.

OWNER: Mr. Dennis Wybrow

ORIGINAL SYSTEM:

The original furnace was a Clare low boy style with an input of approximately 110,000 BTU/hr. It was 20 years old.

The furnace was replaced with a Flame Master FM 105 HB high boy style with a standing pilot. The rated input is 105,000 BTU/hr for this furnace.

DATE OF RETROFIT INSTALLATION:

January 12, 1983

SITE NO. 9

DISCUSSION OF RETROFIT:

The Flame Master furnace was installed with an HEG-R-120 Retrofit. The furnace input was adjusted to approximately 57,000 BTU/hr.

Condensate is removed by a pump to a laundry sink.

The 2½" PVC vent piping rises at 45 degrees from the side of the retrofit towards the front of the unit to clear the flue pipe connection. It rises vertically to the basement ceiling, runs horizontally along the front of the retrofit and then turns 90 degrees to go through the side wall of the house to a vent terminal. The venting required for this arrangement is 20 linear feet of pipe, three 90 degree elbows, and one 45 degree elbows.

SITE NO. 9

SIDE VIEW SHOWING VENTING AND FLUE PIPE TO CHIMNEY

SITE NO. 9

RETROFIT AND FURNACE WITH VENT PIPE AND FLUE PIPE

SITE NO. 9

OPERATING CHARACTERISTICS:

	FURNACE	FURNACE & RETROFIT
Ambient Air Temp.	64°F	64°F
Flue Gas Temp. at Draft Hood Outlet (with dilution air)	435°F	440°F
Flue Gas Temp. at Retrofit Outlet	-	127°F
Temp. Rise Retrofit	0°F	19°F
Temp. Rise Furnace	72°F	64°F
Total Temp. Rise	72°F	83°F
Carbon Dioxide (With dilution air)	2.6%	2.3%
Efficiency	67%	84.9%

FUEL USEAGE COMPARISON:

A comparison of fuel use is done with total gas consumption for the house for a full heating season, both before and since installation.

For the time between September 3, 1981 and May 4, 1982:

Gas consumption: 114,098 C.F.
Degree Days (°F): 7902

Average consumption before the retrofit was installed was 14.4 cubic feet for each degree day.

In the latest heating season from September 2, 1983 to May 3, 1984:

Gas consumption: 102,094 C.F.
Degree Days (°F) 7601.4

Since the retrofit was installed the average gas consumption is 13.4 cubic feet for each degree day.

The gas use has dropped by about 7 percent. This is based on total gas useage, since gas consumption for heating alone could not be isolated.

SITE NO. 9

FUEL USEAGE COMPARISON...con't

An estimate of gas required for water heater use of 2 MCF per month is used to determine heating gas use.

From September 3, 1981 to May 4, 1982:

Gas consumption for heating - 98 098 C.F.
Degree Days (^{o}F) - 7902

Average gas consumption for heating was 12.4 cubic feet per degree day.

From September 2, 1983 to May 3, 1984:

Gas consumption for heating - 86 094 C.F.
Degree Days (^{o}F) - 7601

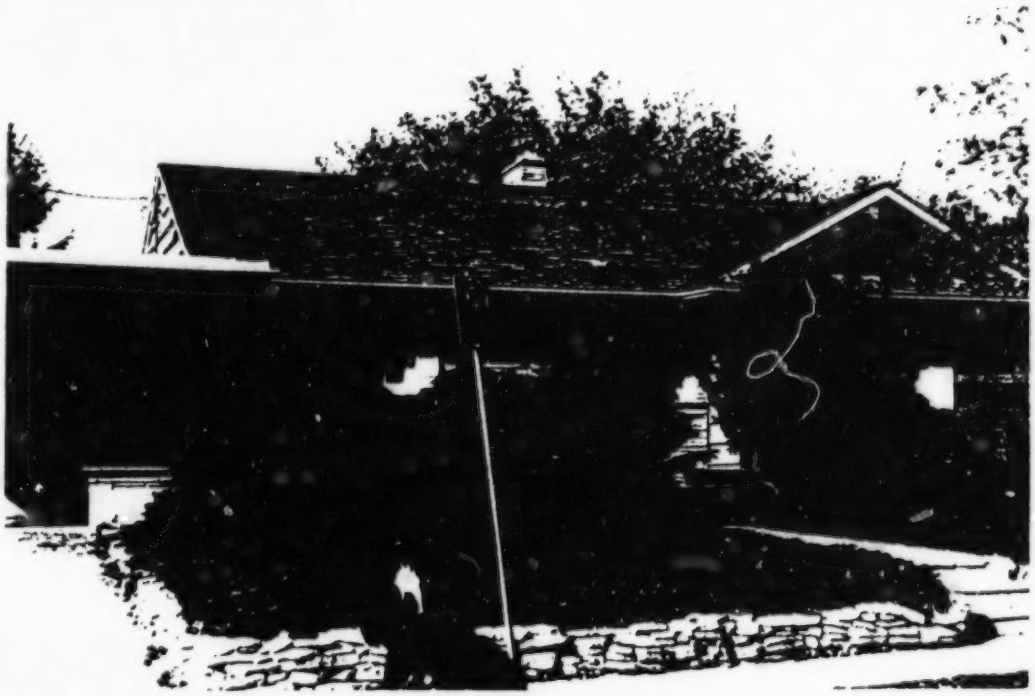
Since the retrofit was installed, the gas required for heating is 11.3 cubic feet per degree day.

The saving in heating gas is 9.1 percent since the retrofit was installed.

SITE NO. 10

LOCATION: 750 Rose Street,
Cambridge, Ontario.

OWNER: Mr. Ted Clare



ORIGINAL SYSTEM:

The original heating system was a Clare low boy gas furnace which was approximately 35 years old. It was fired with an input of 120,000 BTU/hr.

The furnace was replaced by a Clare LBG 80 with a rated input of 80,000 BTU/hr. It is equipped with spark ignition.

DATE OF RETROFIT INSTALLATION:

January 27, 1983.

SITE NO. 10

DISCUSSION OF RETROFIT:

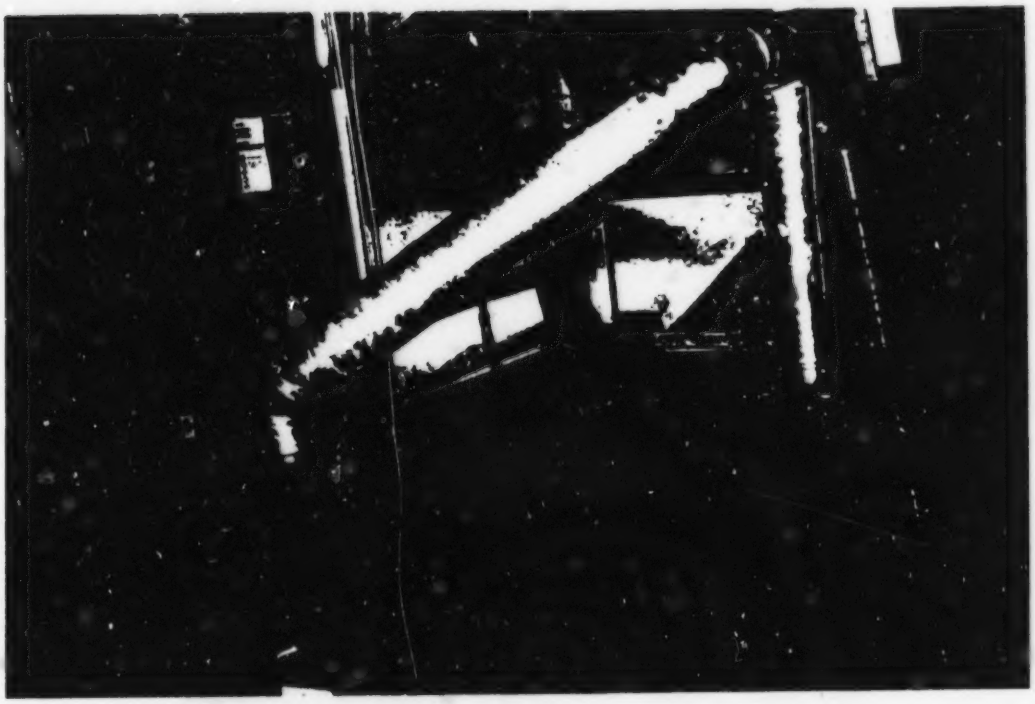
An HEG-R-80 Retrofit was installed with the LBG 80 furnace. The furnace input was adjusted to 75,000 BTU/hr.

The condensate is removed by gravity to a drain. The return air duct is fitted with an electronic air cleaner and a power humidifier is fitted between the supply air and return air ducts. The humidifier is no longer in operation. A 2 ton central air conditioning evaporator coil is located in the supply air duct above the furnace.

The 2½ inch venting rises from the side of the retrofit at a slight angle from vertical to the ceiling. It runs horizontally to the side wall of the basement beneath an addition on the house to a riser and vent terminal. The venting required is 15 feet of pipe and four 90 degree elbows.

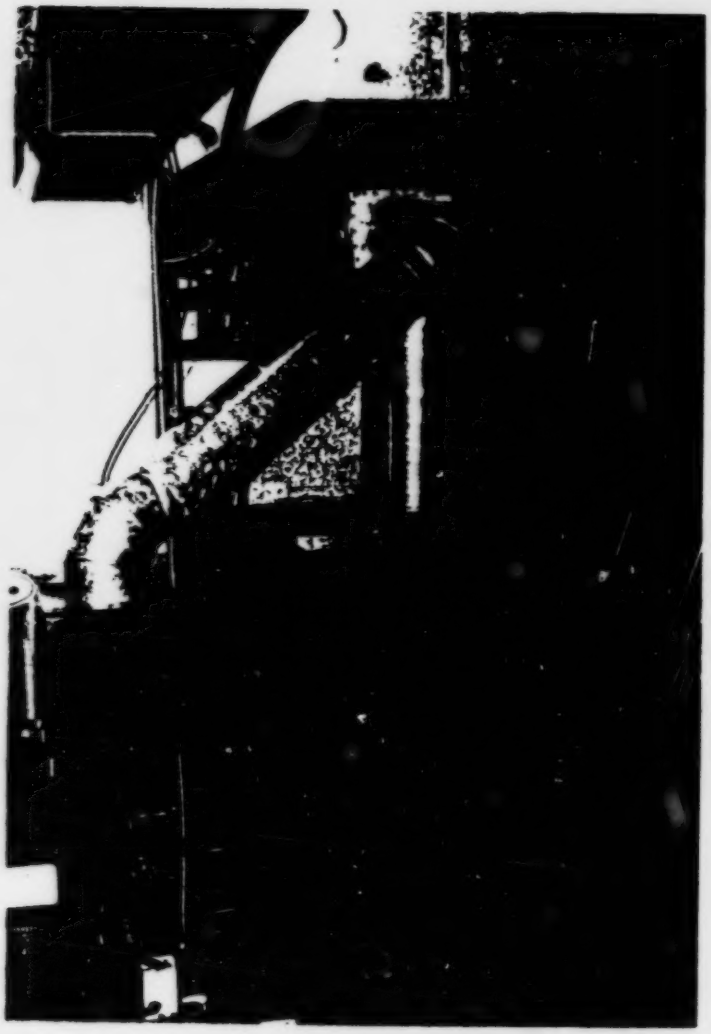
SITE NO. 10

AIR CONDITIONER COIL CONNECTIONS AND DUCTING



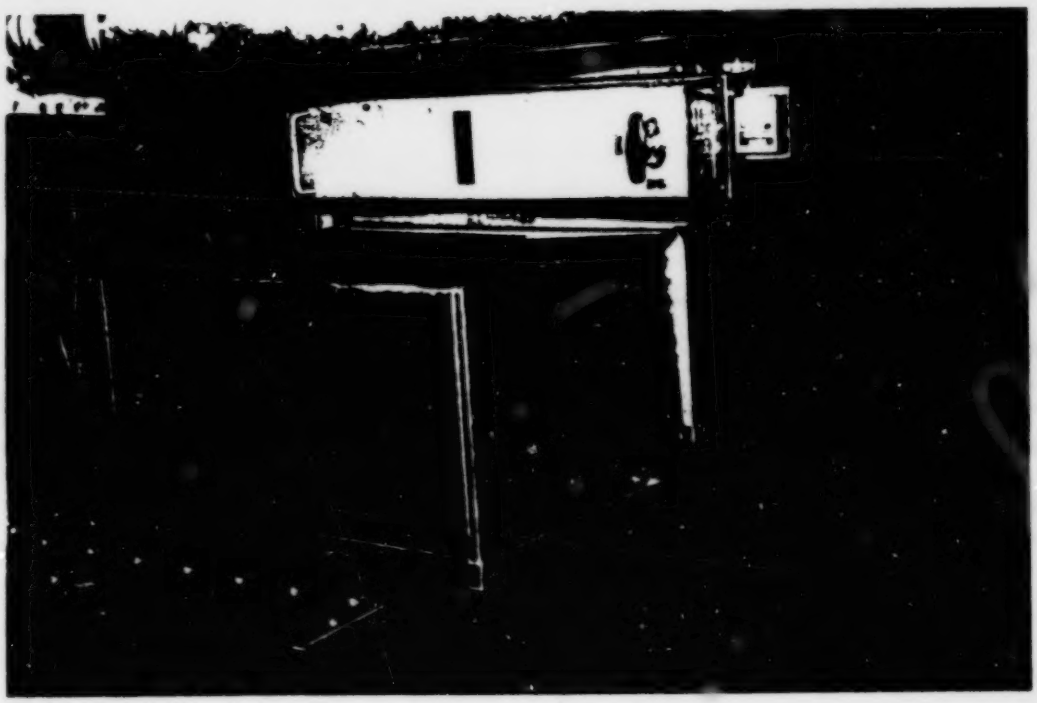
SITE NO. 10

ARRANGEMENT OF INSTALLATION SHOWING CONNECTING FLUE PIPE



SITE NO. 10

RETURN AIR DUCT FOR RETROFIT OF LOW BOY STYLE FURNACES WITH ELECTRONIC AIR CLEANER.



SITE NO. 10

OPERATING CHARACTERISTICS:

	FURNACE ONLY	FURNACE & RETROFIT
Ambient Air Temp.	67°F	67°F
Flue Gas Temp. at Draft Hood Outlet (with dilution air)	275°F	360°F
Flue Gas Temp. at Retrofit Outlet	-	109°F
Air Temp. Rise Across Retrofit Coil	0°F	11°F
Air Temp. Rise Through Furnace	73°F	75°F
Total Air Temp. Rise	73°F	86°F
Carbon Dioxide in Flue Gas (with dilution air)	3.7%	5.7%
(Efficiency (Steady State)	78.7%	88.3%

FUEL USEAGE COMPARISON:

An analysis of gas consumption has been carried out for this installation for a period of a year before, and also since the retrofit was installed.

For the complete year of 1982:

Gas Consumption: 120,100 C.F.
Degree Days °F: 8051.4

Before installation of the retrofit, average gas consumption was 14.9 cubic feet of gas per degree day.

For the period from February 1983 to April 1984:

Gas Consumption: 149,198 C.F.
Degree Days (°F): 10,796.4

Since the retrofit was installed, average gas consumption has been 13.8 cubic feet of gas per degree day.

Gas consumption has dropped by approximately 7 percent at this house.

SITE NO. 11

LOCATION: 20 Woodview Cresc.,
Kitchener, Ontario

OWNER: Mr. D. Godfrey

ORIGINAL SYSTEM:

This installation is in a new house. The furnace is a Lennox 3 Cell G8PX fired at 80,000 BTU/hr.

DATE OF RETROFIT INSTALLATION:

January 31, 1983

SITE NO. 11

DISCUSSION OF RETROFIT:

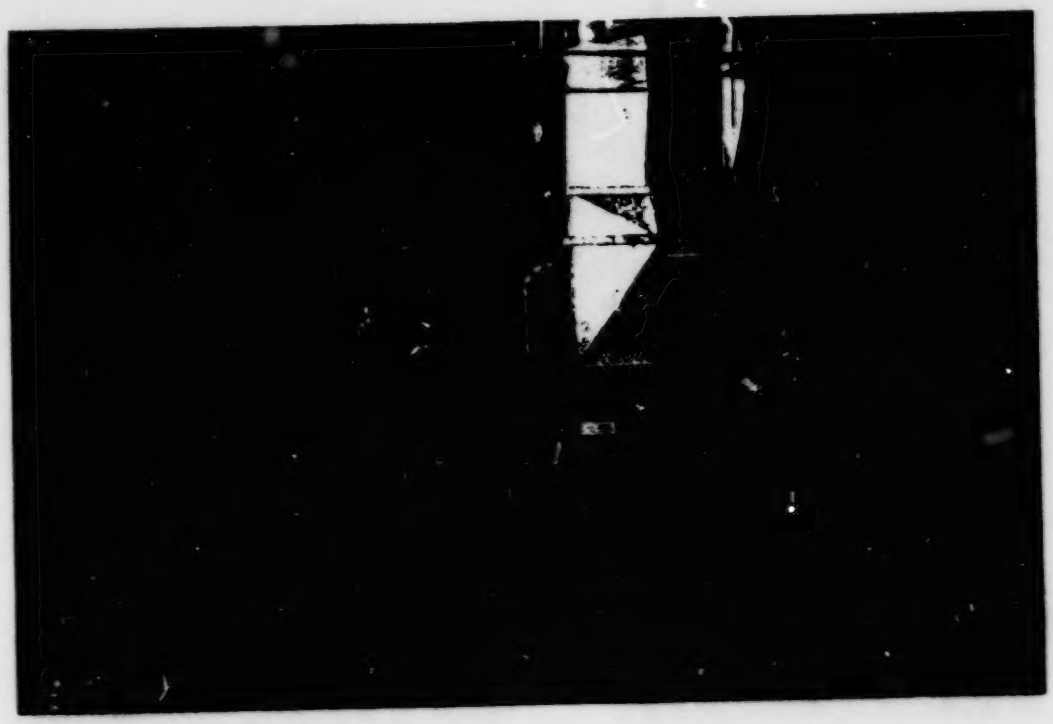
A HEG-R-80 retrofit was installed with the Lennox furnace. The furnace is fired at 80,000 BTU/hr.

A condensate pump is used to remove water from the retrofit.

The 2½ inch vent pipe rises from the side of the retrofit to the basement ceiling. It runs horizontally along the ceiling, turns toward the wall and rises at 45 degrees and then straight through the wall, to a riser and vent terminal. The total amount of venting used is 16 feet of pipe, 5-90 degree elbows, and 1-45 degree elbow.

SITE NO. 11

BACK VIEW SHOWING WATER HEATER, RETROFIT, FURNACE AND VENTING.



SITE NO. 11

FLUE PIPE CONNECTIONS WITH DAMPER.

SITE NO. 11

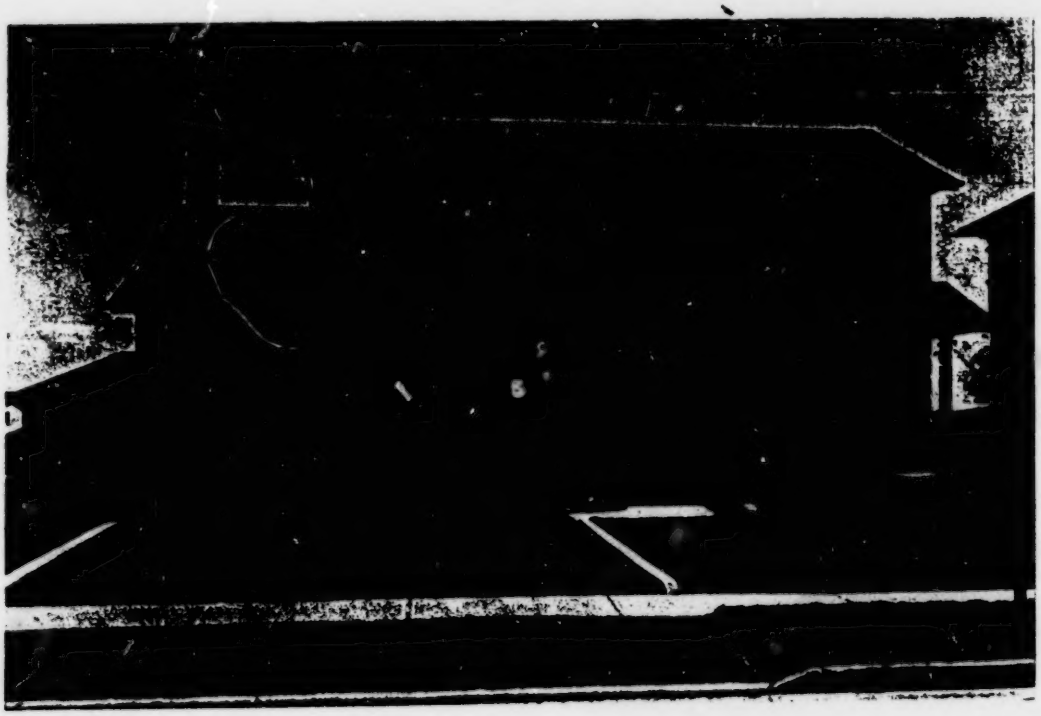
OPERATING CHARACTERISTICS:

	FURNACE ONLY	FURNACE & RETROFIT
Ambient Air Temp.	67°F	67°F
Flue Gas Temp. at Draft Hood Outlet (with Dilution Air)	430°F	560°F
Flue Gas Temp. at Retrofit Outlet	-	136°F
Air Temp. Rise Across Retrofit Coil	0°F	14°F
Air Temp. Rise Through Furnace	97°F	100°F
Total Air Temp. Rise	97°F	114°F
Carbon Dioxide in Flue Gas (with Dilution Air)	2.5%	4.3%
Efficiency (Steady State)	75.7%	87.4%

SITE NO. 12

LOCATION: 117 Sanford Fleming Dr.
Waterloo, Ontario

OWNER: Mr. R. Hollamby



ORIGINAL SYSTEM:

The heating system was a Clawsey-Sohrt furnace model "Preston" 136-GLD-1, with a rated input of 136,000 BTU/hr.

The electronic air cleaner was located in the return air duct.

DATE OF RETROFIT INSTALLATION:

October 12, 1983

SITE NO. 12

DISCUSSION OF RETROFIT:

A HEG-R-125 retrofit was installed with the Preston furnace, which was reduced to an input of 125,000 BTU/hr.

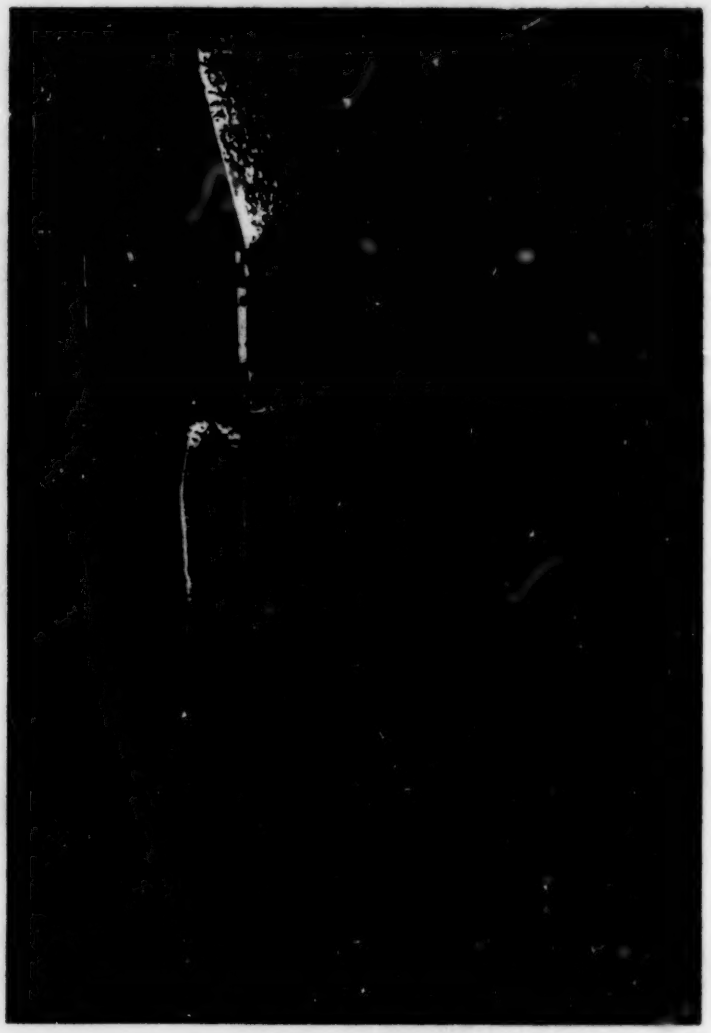
A pump is installed on the retrofit which pumps the condensate to a drain. An electronic air cleaner is installed in the return air duct above the retrofit. The supply air duct has a central air conditioning evaporator coil installed in it.

This retrofit installation uses 4 inch flexible tubing to join the draft hood of the furnace to the coil in the retrofit. No provision is made for operation of the furnace without the retrofit, as was the case on the earlier installations.

The venting is also different from previous installations in that 3 inch PVC vent piping is used along with 3" flexible tubing. The PVC tubing rises vertically from the side of the retrofit to the ceiling and runs horizontally along the ceiling to the chimney. At the chimney a transition piece joins the PVC to the flexible tubing. The tubing runs up the chimney to the terminal at the top of the chimney. The terminal used is a 3 inch plumbing tee. This venting arrangement requires 12 feet of 3" PVC tubing, 2-90 degree elbows, 1-45 degree elbows and 28 feet of 3 inch flexible tubing.

SITE NO. 12

RETROFIT AND FURNACE ARRANGEMENT WITH ELECTRONIC AIR CLEANER IN RETURN AIR DUCT, VENTING, AND FLEXIBLE TUBE FLUE PIPE BETWEEN FURNACE AND RETROFIT.



SITE NO. 12

VENTING ARRANGEMENT SHOWING PVC TRANSITION TO FLEXIBLE PIPE AT CHIMNEY AND FLEXIBLE PIPE BETWEEN FURNACE AND RETROFIT.

SITE NO. 12

OPERATING CHARACTERISTICS:

	FURNACE & RETROFIT
Ambient Air Temp.	77° F
Flue Gas Temp. at Draft Hood Outlet (with Dilution Air)	440°F
Flue Gas Temp. at Retrofit Outlet	152°F
Air Temp. Rise Across Retrofit Coil	12°F
Air Temp. Rise Through Furnace	77°F
Total Air Temp. Rise	89°F
Carbon Dioxide in Flue Gas (with Dilution Air)	3.8%
Efficiency (Steady State)	86.2%

FUEL USEAGE AND COSTS:

Fuel useage for the 1983-84 heating season was recorded and compared with fuel useage from the 1982-83 season. The differences in temperatures between the two seasons are equalized by use of local degree day data.

For 1983-84 (October 24 to March 22):

Total fuel useage: 86,900 CF gas
Degree Days (°F) 6154

The average amount of fuel required is 86,900 cubic feet for 6154 degree days or 14.1 cubic feet of gas per degree day.

For 1982-83 (October 15 to March 24):

Total fuel useage: 104,400 CF
Degree Days (°F) 5480

The average fuel requirement before installation of the retrofit is 19.1 cubic feet of gas per degree day.

A comparison of fuel requirements from before and after installation of the retrofit shows fuel useage to be 26 percent lower since the retrofit was added. This is based on total fuel

SITE NO. 12

FUEL USEAGE AND COSTS...con't

use and does not take into account the amount of fuel required for the hot water heater.

To allow for the water heater, an average gas useage of 2 MCF per month is deducted from the total amounts:

From October 24, 1983 to March 22, 1984:

Gas useage for heating - 76 900 C.F.
Degree Days (^{O}F) - 6154

Gas required for heating is 12.5 cubic feet per degree day.

From October 15, 1982 to March 24, 1983:

Gas useage for heating - 93 400 C.F.
Degree Days (^{O}F) - 5480

Before the retrofit was installed the average gas for heating was 17.0 cubic feet per degree day.

The savings in heating gas useage is 26.5 percent since the installation of the retrofit unit.

POOR

QUALITY

ORIGINAL